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(BAW—10074A(Rev.1))
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SCHROEDINGER EQUATION
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CONTENTS

Category	Page
COAL AND COAL PRODUCTS	5767
PROCESSING	5767
CARBONIZATION	5767
DESULFURIZATION AND PURIFICATION	5768
HYDROGENATION	5768
GASIFICATION	5768
LIQUEFACTION	5772
PYROLYSIS AND CRACKING	5775
SOLVENT EXTRACTION	5775
BY-PRODUCTS	5776
PROPERTIES	5776
WASTE MANAGEMENT	5778
ENVIRONMENTAL ASPECTS	5779
RESERVES AND EXPLORATION	5780
MINING	5780
TRANSPORT AND HANDLING	5784
COMBUSTION	5785
MARKETING AND ECONOMICS	5785
HEALTH AND SAFETY	5786
REGULATIONS	5786
PETROLEUM	5786
RESERVES	5786
GEOLOGY AND EXPLORATION	5787
DRILLING AND PRODUCTION	5788
PROCESSING	5789
PRODUCTS AND BY-PRODUCTS	5789
HEALTH AND SAFETY	5790
MARKETING AND ECONOMICS	5790
WASTE MANAGEMENT	5791
ENVIRONMENTAL ASPECTS	5791
POLICY, LEGISLATION, AND REGULATION	5791
TRANSPORT, PIPELINES, AND HANDLING	5791
PROPERTIES	5792
STORAGE	5792
COMBUSTION	5792
NATURAL GAS	5792
RESERVES	5792
GEOLOGY AND EXPLORATION	5792
DRILLING, PRODUCTION, AND PROCESSING	5793
PRODUCTS AND BY-PRODUCTS	5793
HEALTH AND SAFETY	5793
MARKETING AND ECONOMICS	5793
ENVIRONMENTAL EFFECTS	5793
ARTIFICIAL STIMULATION, PLOWSHARE, ETC.	5793
POLICY, LEGISLATION, AND REGULATION	5793
TRANSPORT, PIPELINES, AND HANDLING	5793
PROPERTIES	5794
COMBUSTION	5794
STORAGE	5794
OIL SHALES AND TAR SANDS	5794
SITE GEOLOGY AND HYDROLOGY	5794
SITE GEOLOGY	5794
DRILLING, FRACTURING, AND MINING	5795
OIL PRODUCTION, RECOVERY, AND REFINING	5795
IN SITU METHODS, TRUE AND MODIFIED	5795
SURFACE METHODS	5796
REFINING	5796
PROPERTIES AND COMPOSITION	5796
DIRECT USES AND BY-PRODUCTS	5796
HEALTH AND SAFETY	5796
ENVIROMENTAL ASPECTS	5796
FISSION FUELS	5797
RESERVES	5797
EXPLORATION	5797
MINING	5797
FEED PROCESSING	5797
ENRICHMENT	5798
LASER EXCITATION	5798
FUELS PRODUCTION AND PROPERTIES	5798
SPENT FUELS REPROCESSING	5799
TRANSPORT AND STORAGE	5799
MARKETING AND ECONOMICS	5800
WASTE MANAGEMENT	5800
WASTE PROCESSING	5800
WASTE DISPOSAL AND STORAGE	5801
ENVIRONMENTAL ASPECTS	5803
HEALTH AND SAFETY	5803
REGULATIONS	5804
ACCOUNTABILITY AND SAFEGUARDS	5804
ADMINISTRATIVE AND REGULATORY	5805
FUSION FUELS	5806
PROCESSING	5806
ISOTOPE AND RADIATION SOURCE TECHNOLOGY	5806
PHYSICAL ISOTOPE SEPARATION	5806
RADIATION SOURCES	5806
DESIGN AND FABRICATION	5806
OTHER INDUSTRIAL USES	5806
ISOTOPIC POWER SUPPLIES	5806
DESIGN AND FABRICATION	5806
HYDROGEN	5806
PRODUCTION	5806
ELECTROLYSIS	5806
THERMOCHEMICAL PROCESSES	5806
PROPERTIES	5807
OTHER SYNTHETIC AND NATURAL FUELS	5807
HYDROCARBON FUELS	5807
PROPERTIES	5807
PREPARATION	5807
CHEMICAL SYNTHESIS	5807
PREPARATION FROM WASTES OR BIOMASS	5808
PREPARATION	5809
CHEMICAL SYNTHESIS	5809
PREPARATION FROM WASTES OR BIOMASS	5809
PROPERTIES	5809
PREPARATION	5809
SOLID WASTE FUELS	5809
HYDRO ENERGY	5810
RESOURCES AND AVAILABILITY	5810
SITE GEOLOGY AND METEOROLOGY	5810
PLANT DESIGN AND OPERATION	5810
ECONOMICS AND MANAGEMENT	5810
ENVIRONMENTAL ASPECTS	5810
SOLAR ENERGY	5810
RESOURCES AND AVAILABILITY	5811
ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS	5812
SOLAR ENERGY CONVERSION	5812
PHOTOVOLTAIC CONVERSION	5812
THERMIONIC AND THERMOELECTRIC CONVERSION	5817
BIOMASS PRODUCTION AND CONVERSION	5817
PHOTOVOLTAIC POWER PLANTS	5817
SOLAR THERMAL POWER PLANTS	5817
CENTRAL RECEIVER	5818
DISTRIBUTED COLLECTOR	5818
OCEAN THERMAL GRADIENT POWER PLANTS	5818
SOLAR RADIATION UTILIZATION	5819
SPACE HEATING AND COOLING	5819
AGRICULTURAL AND INDUSTRIAL PROCESS HEAT	5820
WATER HEATING	5820
OTHER	5821

CONTENTS (continued)

Category	Page
SOLAR ENERGY—Continued	
SOLAR COLLECTORS AND CONCENTRATORS	5821
HEAT STORAGE	5824
GEOTHERMAL ENERGY	5827
RESOURCE STATUS AND ASSESSMENT	5827
NON-USA	5827
GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS	5827
USA	5827
NON-USA	5827
GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY	5828
GEOPHYSICAL TECHNIQUES AND SURVEYS	5828
GEOCHEMICAL TECHNIQUES AND SURVEYS	5829
ECONOMIC AND FINANCIAL ASPECTS	5829
ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL	5829
GEOTHERMAL POWER PLANTS	5830
DESIGN AND OPERATION	5830
POWER PLANT SYSTEMS AND COMPONENTS	5830
GEOTHERMAL ENGINEERING	5830
CORROSION, SCALING, AND MATERIALS DEVELOPMENT	5830
GEOTHERMAL RESERVOIR AND WELL PERFORMANCE	5830
SAFETY AND CONTROL	5830
RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY	5830
DIRECT ENERGY UTILIZATION	5830
GEOTHERMAL DATA AND THEORY	5831
PROPERTIES OF AQUEOUS SOLUTIONS	5831
PROPERTIES OF MINERALS AND ROCKS	5831
ROCK-WATER-GAS INTERACTIONS	5831
ISOTOPE AND TRACE ELEMENT STUDIES	5831
TIDAL POWER	5831
TIDAL POWER PLANTS	5831
DESIGN AND OPERATION	5831
WAVE ENERGY CONVERTERS	5831
WIND ENERGY	5832
ECONOMICS	5832
WIND ENERGY ENGINEERING	5832
APPLICATIONS	5832
TURBINE DESIGN AND OPERATION	5832
SITE CHARACTERISTICS	5832
ELECTRIC POWER ENGINEERING	5832
POWER PLANTS AND POWER GENERATION	5832
COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS	5833
POWER CYCLES	5834
WASTE-FUELED SYSTEMS	5834
COMPONENTS	5835
WASTE HEAT UTILIZATION	5840
ECONOMICS	5840
OFF-PEAK ENERGY STORAGE	5840
ENVIRONMENTAL ASPECTS	5841
THERMAL EFFLUENTS	5841
NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL	5841
POWER TRANSMISSION AND DISTRIBUTION	5841
AC SYSTEMS, EHV AND UHV	5842
SUPERCONDUCTING AND CRYOGENIC SYSTEMS	5842
NUCLEAR POWER PLANTS	5842
POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED	5843
POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED	5846
POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED	5848
POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED	5851
POWER REACTORS, BREEDING	5852
REGULATION AND LICENSING	5863
ECONOMICS	5864
CONSTRUCTION AND OPERATION	5864
FUEL CYCLE	5865
PROCESS HEAT REACTORS	5865
NUCLEAR REACTOR TECHNOLOGY	5866
THEORY AND CALCULATION	5867
COMPONENTS AND ACCESSORIES	5868
FUEL ELEMENTS	5873
CONTROL SYSTEMS	5874
ENVIRONMENTAL ASPECTS	5875
SITING	5875
RADIOACTIVE EFFLUENTS	5876
CHEMICAL AND THERMAL EFFLUENTS	5876
RESEARCH, TEST, AND EXPERIMENTAL REACTORS	5876
PLUTONIUM AND ISOTOPE PRODUCTION REACTORS	5877
PROPULSION REACTORS	5877
REACTOR SAFETY	5877
ENERGY STORAGE	5885
MAGNETIC	5885
COMPRESSED GAS	5885
PUMPED HYDRO	5885
FLYWHEELS	5885
THERMAL	5885
CHEMICAL	5885
BATTERIES	5885
DESIGN AND DEVELOPMENT	5885
PERFORMANCE AND TESTING	5886
MATERIALS, COMPONENTS, AND AUXILIARIES	5886
APPLICATIONS	5887
ENERGY MANAGEMENT AND POLICY	5887
ENERGY ANALYSIS AND MODELING	5887
ECONOMICS AND SOCIOLOGY	5888
ENVIRONMENT, HEALTH, AND SAFETY	5888
ENERGY RESOURCES	5889
RESEARCH AND DEVELOPMENT	5890
NUCLEAR ENERGY	5890
CONSERVATION	5890
SUPPLY, DEMAND, AND FORECASTING	5891
POLICY, LEGISLATION, AND REGULATION	5892
FOSSIL FUELS	5892
COAL	5892
PETROLEUM	5893
NATURAL GAS	5893
OIL SHALES AND TAR SANDS	5893
HYDROGEN AND SYNTHETIC FUELS	5893
ELECTRIC POWER	5894
ELECTRIC POWER GENERATION	5894
CONSUMPTION AND UTILIZATION	5894
UNCONVENTIONAL SOURCES AND POWER GENERATION	5895
SOLAR	5895
GEOTHERMAL	5895
OTHER	5895
ENERGY CONVERSION	5895
MHD GENERATORS	5895
DESIGN AND DEVELOPMENT	5895
PERFORMANCE AND TESTING	5895
MATERIALS, COMPONENTS, AND AUXILIARIES	5895
DUCT ENGINEERING AND FLUID DYNAMICS	5896
MATERIALS, COMPONENTS, AND AUXILIARIES	5896
FUEL CELLS	5896
DESIGN AND DEVELOPMENT	5896
PERFORMANCE AND TESTING	5896
MATERIALS, COMPONENTS, AND AUXILIARIES	5896
ELECTROCHEMISTRY, MASS TRANSFER, AND THERMODYNAMICS	5896

CONTENTS (continued)

Category	Page
ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION	5897
BUILDINGS	5897
RESIDENTIAL BUILDINGS	5898
OFFICE BUILDINGS	5898
COMMERCIAL AND INDUSTRIAL BUILDINGS	5898
TRANSPORTATION	5899
AIR AND AEROSPACE	5899
RAILWAY	5899
LAND AND ROADWAY	5899
PIPELINE	5899
INDUSTRY AND AGRICULTURE	5899
ENERGY SOURCES	5899
MATERIALS	5899
EQUIPMENT AND PROCESSES	5900
WASTE HEAT RECOVERY AND UTILIZATION	5901
INDUSTRIAL WASTE MANAGEMENT	5901
MUNICIPAL WASTE MANAGEMENT	5901
ADVANCED AUTOMOTIVE PROPULSION SYSTEMS	5901
INTERNAL COMBUSTION ENGINES	5901
SPARK-IGNITION	5901
DIESEL	5901
TURBINE	5902
ELECTRIC-POWERED SYSTEMS	5902
FLYWHEEL PROPULSION	5903
VEHICLE DESIGN FACTORS	5903
ENGINE SYSTEM	5903
EMISSION CONTROL	5904
NITROGEN OXIDES	5904
CARBON MONOXIDE	5904
HYDROCARBONS	5904
ALTERNATIVE FUELS	5904
MATERIALS	5904
METALS AND ALLOYS	5905
PREPARATION AND FABRICATION	5905
STRUCTURE AND PHASE STUDIES	5906
MECHANICAL PROPERTIES	5906
PHYSICAL PROPERTIES	5908
CORROSION AND EROSION	5909
RADIATION EFFECTS	5910
CERAMICS, CERMETS, AND REFRACTORIES	5911
PREPARATION AND FABRICATION	5911
STRUCTURE AND PHASE STUDIES	5911
MECHANICAL PROPERTIES	5911
PHYSICAL PROPERTIES	5911
CORROSION AND EROSION	5912
RADIATION EFFECTS	5912
COMPOSITE MATERIALS	5912
PREPARATION AND FABRICATION	5912
MECHANICAL PROPERTIES	5912
PHYSICAL PROPERTIES	5912
POLYMERS AND PLASTICS	5913
PREPARATION AND FABRICATION	5913
MECHANICAL PROPERTIES	5913
PHYSICAL PROPERTIES	5913
OTHER MATERIALS	5913
PREPARATION AND MANUFACTURE	5913
STRUCTURE AND PHASE STUDIES	5913
PROPERTIES	5914
CORROSION, EROSION, AND DEGRADATION	5914
RADIATION EFFECTS	5914
CHEMISTRY	5914
ANALYTICAL AND SEPARATIONS CHEMISTRY	5914
ACTIVATION AND NUCLEAR REACTION PROCEDURES	5914
CHEMICAL PROCEDURES	5915
RADIOMETRIC AND RADIOCHEMICAL PROCEDURES	5915
SPECTRAL PROCEDURES	5915
SEPARATION PROCEDURES	5916
INORGANIC AND PHYSICAL CHEMISTRY	5916
CHEMICAL AND PHYSICOCHEMICAL PROPERTIES	5917
ISOTOPE EFFECTS	5918
ISOTOPE EXCHANGE AND ISOTOPE SEPARATION	5918
ORGANIC CHEMISTRY	5918
CHEMICAL AND PHYSICOCHEMICAL PROPERTIES	5918
ISOTOPE EFFECTS	5919
ISOTOPE EXCHANGE AND ISOTOPE SEPARATION	5919
RADIATION CHEMISTRY	5919
RADIOCHEMISTRY AND NUCLEAR CHEMISTRY	5920
HOT-ATOM CHEMISTRY	5920
PROPERTIES OF RADIOACTIVE MATERIALS	5920
RADIOISOTOPE PRODUCTION	5920
COMBUSTION CHEMISTRY	5920
ENGINEERING	5921
GENERAL ENGINEERING	5921
FACILITIES AND EQUIPMENT	5921
CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES	5923
PROTECTIVE STRUCTURES AND EQUIPMENT	5923
HANDLING EQUIPMENT AND PROCEDURES	5923
SHIPPING CONTAINERS	5923
MINING AND DRILLING EQUIPMENT AND FACILITIES	5924
LASERS	5924
HEAT TRANSFER AND FLUID FLOW	5925
MATERIALS TESTING	5926
SAFETY ENGINEERING	5926
ELECTRONIC CIRCUITS AND DEVICES	5926
SOLID WASTE PROCESSING PLANTS AND EQUIPMENT	5927
COMBUSTION SYSTEMS	5927
UNDERGROUND ENGINEERING	5928
MARINE ENGINEERING	5928
PARTICLE ACCELERATORS	5928
AUXILIARIES AND COMPONENTS	5928
EXPERIMENTAL FACILITIES AND EQUIPMENT	5928
INSTRUMENTATION	5928
RADIATION INSTRUMENTATION	5928
GENERAL DETECTORS AND MONITORS	5928
NUCLEAR SPECTROSCOPIC INSTRUMENTATION	5928
RADIOMETRIC INSTRUMENTS	5929
MISCELLANEOUS INSTRUMENTS	5929
EXPLOSIONS AND EXPLOSIVES	5929
CHEMICAL	5929
NUCLEAR	5930
CIVIL USES	5930
ENVIRONMENTAL SCIENCES, ATMOSPHERIC	5930
BASIC STUDIES	5930
CHEMICALS MONITORING AND TRANSPORT	5930
RADIOACTIVE MATERIALS MONITORING AND TRANSPORT	5931
THERMAL EFFLUENTS MONITORING AND TRANSPORT	5932
SITE RESOURCE AND USE STUDIES	5932
REGULATIONS	5932
ENVIRONMENTAL SCIENCES, TERRESTRIAL	5932
BASIC STUDIES	5932
CHEMICALS MONITORING AND TRANSPORT	5932
RADIOACTIVE MATERIALS MONITORING AND TRANSPORT	5933
SOIL	5933
THERMAL EFFLUENTS MONITORING AND TRANSPORT	5934
SITE RESOURCE AND USE STUDIES	5934
ENVIRONMENTAL SCIENCES, AQUATIC	5934
BASIC STUDIES	5934
CHEMICALS MONITORING AND TRANSPORT	5934
RADIOACTIVE MATERIALS MONITORING AND TRANSPORT	5935

CONTENTS (continued)

Category	Page
ENVIRONMENTAL SCIENCES, AQUATIC—Continued	
WATER	5935
AQUATIC ECOSYSTEMS AND FOOD CHAINS	5935
THERMAL EFFLUENTS MONITORING AND TRANSPORT	5936
SITE RESOURCE AND USE STUDIES	5936
ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES	5936
SOCIAL AND ECONOMIC STUDIES	5936
ASSESSMENT OF ENERGY TECHNOLOGIES	5936
ENVIRONMENTAL IMPACT STATEMENTS	5936
BIOMEDICAL SCIENCES, BASIC STUDIES	5936
BIOCHEMISTRY	5936
TRACER TECHNIQUES	5937
CYTOLOGY	5937
METABOLISM	5938
MEDICINE	5938
TRACER TECHNIQUES	5938
PHYSIOLOGICAL SYSTEMS	5938
BIOMEDICAL SCIENCES, APPLIED STUDIES	5939
EXTERNAL SOURCE	5939
BASIC STUDIES	5939
RADIATION EFFECTS ON ANIMALS	5939
MAN	5939
VERTEBRATES	5939
RADIONUCLIDE EFFECTS - INTERNAL SOURCE	5940
MAN	5940
PLANTS	5940
NUCLIDE KINETICS AND TOXICOLOGY	5940
ANIMALS	5940
PLANTS	5940
THERMAL EFFECTS	5940
VERTEBRATES	5940
CHEMICALS METABOLISM AND TOXICITY	5941
INVERTEBRATES	5941
VERTEBRATES	5942
MAN	5942
HEALTH AND SAFETY	5943
GEOSCIENCES	5943
GEOLOGY AND HYDROLOGY	5943
GEOPHYSICS	5943
SEISMOLOGY AND TECTONICS	5943
GEOPHYSICAL SURVEY METHODS	5944
MINERALOGY, PETROLOGY, AND ROCK MECHANICS	5944
GEOCHEMISTRY	5944
OCEANOGRAPHY	5944
PHYSICS RESEARCH	5944
ASTROPHYSICS AND COSMOLOGY	5944
STARS	5944
SOLAR PHENOMENA	5944
GALAXIES	5945
COSMOLOGY	5945
PLANETARY PHENOMENA	5945
ATMOSPHERIC PHYSICS	5945
AURORAL AND IONOSPHERIC PHENOMENA	5945
MAGNETOSPHERIC PHENOMENA	5945
ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS	5945
BEAMS AND THEIR REACTIONS	5945
ATOMIC AND MOLECULAR PROPERTIES	5946
POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES	5947
COLLISION PHENOMENA	5947
ATOMIC AND MOLECULAR THEORY	5951
GENERAL FLUID DYNAMICS	5951
SUPERFLUIDITY	5951
HIGH ENERGY PHYSICS	5952
PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL	5952
ELECTROMAGNETIC INTERACTIONS	5952
WEAK INTERACTIONS	5952
STRONG BARYON-INDUCED INTERACTIONS	5952
STRONG MESON-INDUCED INTERACTIONS	5952
PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL	5953
ELECTROMAGNETIC INTERACTIONS	5953
WEAK INTERACTIONS	5953
STRONG INTERACTIONS, GENERAL	5953
STRONG INTERACTIONS, BARYON NO.=0	5953
STRONG INTERACTIONS, BARYON NO.=1	5953
STRONG INTERACTIONS, BARYON NO. GREATER THAN 1	5953
PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES	5954
APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS	5954
APPLICATIONS TO STRONG INTERACTIONS	5954
FIELD THEORY	5954
PHYSICS RESEARCH (CONT.)	5954
NUCLEAR PHYSICS	5954
NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL	5954
NUCLEAR REACTIONS AND SCATTERING	5954
NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL	5954
NUCLEAR REACTIONS AND SCATTERING	5954
NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL	5955
NUCLEAR REACTIONS AND SCATTERING	5955
NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL	5955
NUCLEAR REACTIONS AND SCATTERING	5955
NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL	5955
NUCLEAR REACTIONS AND SCATTERING	5955
NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL	5955
NUCLEAR REACTIONS AND SCATTERING	5955
SPONTANEOUS AND INDUCED FISSION	5955
RADIOACTIVE DECAY	5955
SPONTANEOUS AND INDUCED FISSION	5955
NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL	5955
NUCLEAR REACTIONS AND SCATTERING	5955
SPONTANEOUS AND INDUCED FISSION	5956
NUCLEAR THEORY	5956
NUCLEAR STRUCTURE	5956
NUCLEAR REACTIONS AND SCATTERING	5957
RADIOACTIVE DECAY	5957
RADIATION AND SHIELDING PHYSICS	5957
RADIATION PHYSICS	5957
SHIELDING CALCULATIONS AND EXPERIMENTS	5957
NEUTRON INTERACTIONS WITH MATTER	5957
SOLID STATE PHYSICS	5957
SUPERCONDUCTIVITY	5957
ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA	5957
STATISTICAL PHYSICS AND THERMODYNAMICS	5958
FUSION ENERGY	5958
PLASMA RESEARCH	5958
PLASMA CONFINEMENT AND HEATING	5958
PLASMA DIAGNOSTICS	5958
PLASMA KINETICS - GENERAL	5959
PLASMA KINETICS - EXPERIMENTAL	5959
PLASMA KINETICS - THEORETICAL	5959
PLASMA PRODUCTION	5959
PLASMA INSTABILITIES	5960
PLASMA WAVE PHENOMENA	5961
FUSION POWER PLANTS	5963
PHYSICS AND BLANKET ENGINEERING	5964
MAGNET COILS AND FIELDS	5965
POWER SUPPLIES AND CIRCUITRY	5965
COOLING SYSTEMS	5965
FUEL SYSTEMS	5966
RADIATION HAZARDS	5966

CONTENTS (continued)

Category	Page
FUSION ENERGY—Continued	
INERTIAL CONFINEMENT SYSTEMS	5967
COMPONENT DEVELOPMENT AND TESTING	5968
GENERAL AND MISCELLANEOUS	5669
MANAGEMENT	5969
MATHEMATICS AND COMPUTERS	5969
INFORMATION HANDLING	5972
CIVILIAN DEFENSE	5972
CORPORATE INDEX	1C
AUTHOR INDEX	15A
SUBJECT INDEX	55S
REPORT NUMBER INDEX	159R

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Volume 2, Number 23, December 15, 1977

ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

55546 (EPRI-SR—36) **Proceedings from the workshop to identify research and data required to improve North American long-term coal supply analysis, Tampa, Florida, December 9—10, 1975.** (Sigma Research, Inc. Richland, Wash. (USA)). Feb 1976. 67p. Dep. NTIS, PC A04/MF A01.

In this workshop, conducted for EPRI, an attempt was made to identify topical areas of needed research, to put priorities on each area, and to quantify the research effort of each area. This report contains the recommendations of approximately thirty coal economists, engineers, geologists, and others who focused on six areas of research interest: reserves and resources; mining and transportation costs; impact of new utilization technology; impact of government policies; impact of coal industry structure; and integrating the above.

55547 (USGS-CIRC—757) **Coal geology and the future. Symposium abstracts and selected references.** Meissner, C.R. Jr.; Cecil, C.B.; Stricker, G.D. (eds.). (Geological Survey, Reston, Va. (USA)). 1977. 24p. (CONF-7609153—(Absts.)). Survey, Arlington, VA.

From Symposium on coal geology and the future; Reston, Virginia, USA (27 Sep 1976).

This symposium, sponsored by the U. S. Geological Survey, was held in Reston, Va., September 27—28, 1976. The primary purpose of this meeting was to identify present and future geological research requirements in coal exploration, mining, and utilization in response to the ever-expanding demand for coal to meet the Nation's energy needs. In order to accomplish this objective, leading research scientists from State and Federal agencies, industry, and universities were invited to present results of their investigations emphasizing problem areas and further research needs. The abstracts, with selected references, included in this circular should serve as a valuable summary and reference source for those who wish to pursue any or all facets of the topics covered. The program was structured to encompass both theoretical and applied geological research from the origin of coal to ultimate utilization. The first technical session considered the general geology of coal from the peat-forming environment through the genesis of bituminous and anthracite coal. The second session was devoted to geology as applied to coal exploration, coal mining, and reclamation of mined land. Geological science as applied to utilization of coal in the generation of electricity, coke manufacture, gasification, and liquefaction was the focus of the third session. Finally, the various programs in coal geology of the U. S. Geological Survey (U.S.G.S.) were considered.

PROCESSING

REFER ALSO TO CITATION(S) 55983

55548 (N—76-31332) **Sulfidation of 310 stainless steel at sulfur potentials encountered in coal conversion systems.** Rao, D.B.; Nelson, H.G. (National Aeronautics and Space Administration, Moffett Field, Calif. (USA). Ames Research Center). Sep 1976. 31p. (NASA-TM-X—73-166). Dep. NTIS, PC A03/MF A01.

The sulfidation of SAE 310 stainless steel was carried out in gas mixtures of hydrogen and hydrogen sulfide over a range of sulfur potentials anticipated in advanced coal gasification processes. The kinetics, composition, and morphology of sulfide scale formation were studied at a fixed temperature of 1065°K over a range of sulfur potentials from 1.5×10^{-4} Nm^{-2} to 9×10^{3} Nm^{-2}. At all sulfur potentials investigated, the sulfide scales were found to be multilayered. The relative thickness of the individual layers as well as the composition was found to depend on the sulfur potential. The reaction was found to obey the parabolic rate law after an initial transient period. Considerably longer transient periods were found to be due to unsteady state conditions resulting from compositional variations in the spinel layer. The sulfur pressure dependence on the parabolic rate constant was found to best fit the equation K/sub p/ = Const. P/sub S_2//sup 1/n/ where n equals 3.7. The growth of the outer layers was found to be primarily due to the diffusion of metal ions, iron being the predominant species. The inner layer growth was due to the dissociation of the primary product at the alloy-scale interface and depended on the activity of chromium.

CARBONIZATION

REFER ALSO TO CITATION(S) 55558, 55589, 55644

55549 **Activation energies of carbonization of coals.** Biswas, S.C.; Kini, K.A.; Das Gupta, N.N.; Lahiri, A. (Cent Fuel Res Inst, Dhanbad, India). *J. Mines, Met. Fuels;* **24**: No. 9, 300-301(Sep 1976).

In an earlier study a relationship was shown between the chemical composition of coal and the amounts of gases yielded during the vacuum pyrolysis of coal at 1000°C. It was suggested that the hydrogen originated from the alicyclic structures $\pi 2^{-}$ and also during condensation of ring systems to form the polynuclear aromatic structures characteristic of coke. The evolution of carbon monoxide was considered to take place from the carbonyl groups and also from the splitting of ether groups. In this paper, the energies of activation of evolution of gases, particularly of hydrogen and carbon monoxide, at temperatures between 700°C and 800°C are determined. 6 refs.

55550 **Coke production: metallurgical coke, foundry coke, molded coke.** Foch, P. (Charbonnages de Fr). *Rev. Energ.;* **28**: No. 291, 111-117(Feb 1977). (In French).

The use of coke in blast furnaces, foundries, and chemical industry is surveyed. It is argued that the direct reduction process is not likely to replace the use of coke in blast furnace steel production by more than 5%. This is due to the significant improvements in the blast furnace practice in the last few years. Modern blast furnaces have the capacities of between 5,000 and 10,000 t of pig iron per day. At the same time, the specific coke consumption, i.e., the consumption of coke per ton of cast iron, has more or less gone from 1,000 kg to about 380 to 400 kg, to which one must add 50 to 80 kg of fuel. In France for example, in 1975 the steelworks industry consumed 11 million tons of coke against 4,000,000 tons in foundries and almost as much in the chemical industry.

55551 **Automation of coking plant servicing machines.** Seiler, W.; Stein, M. (August-Thyssen-Huette, Hamborn Works, Ger). *AEG-Telefunken Prog.;* No. 4, 111-117(1976).

In 1974/75 AEG-Telefunken designed, supplied and handed over to the Hamborn coking plant of the August Thyssen steelworks the electrical equipment for three servicing machines for the extension of Battery VI. After a description of the various sequences of operation, reference is made to the devices with which the coking plants were equipped, and the techniques employed. The stringent requirements imposed are satisfied by the employment of modern modular systems.

55552 **Industrialization of briquette blend coking process.** Yoshinaga, M.; Sanada, M.; Utsunomiya, M. (Nippon Steel Corp, Jpn). *Ironmaking Proc., Metall. Soc. AIME;* **35**: 256-275(1976).

The briquette blend coking process developed by N.S.C. consists of blending fine coal and coal briquettes uniformly, charging the blend in coke ovens of the conventional type. This process has the following advantages: It has the effect of remarkably improving the coke strength. Also, it can be adopted readily only by adding coal briquetting equipment and some ancillary equipment to an existing coking process line. A detail description is presented on how

the briquette blend coking process came to be commercially applied in the Tobata Area of Yawata Works and what effects it has. 9 refs.

DESULFURIZATION AND PURIFICATION

55553 (IS-T—779) **Floatability of coal and pyrite.** Le, H.V. (Ames Lab., Iowa (USA)). Jul 1977. Contract W-7405-ENG-82. 112p. Dep. NTIS, PC A06/MF A01.

An experimental investigation was carried out to improve the froth flotation method of separating coal pyrite. The effect of several surface active agents on the floatability of an Iowa coal and its associated pyrite was studied in both the presence and absence of methyl isobutyl carbinol (MIBC), a commonly used frother. The effectiveness of a special method of chemical pretreatment for depressing pyrite was also investigated. The zeta potential of the same coal and pyrite was measured under the same conditions used in the flotation tests (in the absence of frother). In the absence of MIBC, the floatability of coal and pyrite was low, and appeared to depend on pH. The maximum recovery of pyrite was obtained at a pH of 4.5 with recovery being less at higher or lower pH. The addition of a small amount of MIBC significantly increased the recovery of coal and pyrite with the increase in the recovery of coal being much greater than the increase in the recovery of pyrite. Also in the presence of MIBC, the floatability of coal and pyrite seemed to be affected more by pH than in the absence of MIBC. On the other hand, several potential pyrite depressants were found to be ineffective in the presence of MIBC. The special chemical pretreatment reduced the floatability of pyrite markedly while not greatly affecting the floatability of coal. Measurement of the zeta potential of coal and pyrite suspensions in dilute aqueous solutions of various reagents provided an indication of adsorption phenomena. However, there appeared to be no consistent direct correlation between zeta potential and floatability.

55554 **Sulfur, moisture and ash reduction in coal preparation research.** Warnke, W.E.; Deurbrouck, A.W. (US Bur of Mines, Pittsburgh, Pa). *Min. Congr. J.;* **63**: No. 4, 43-47(Apr 1977).

While the research and development program discussed is concerned with the removal of pyrite and ash minerals, much of the coal in the Midwestern and Appalachian regions contains from 1 to 3% organic sulfur and therefore cannot be physically cleaned sufficiently to meet the present EPA requirements for SOsub x emissions. In the past, mild chemical treatment and the use of bacteria as agents to attach the sulfur have been tried; however, none of these simple and inexpensive treatments have proved effective for organic sulfur removal. Presently, the Bureau of Mines is engaged in a basic research program designed to develop innovative chemical treatments specifically aimed at organic sulfur removal. 11 refs.

HYDROGENATION

REFER ALSO TO CITATION(S) 55589, 55985

55555 (BNWL-SA—6055) **Homogeneous catalytic hydrogenations of complex carbonaceous substrates.** Cox, J.L.; Wilcox, W.A.; Roberts, G.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 5 Nov 1976. Contract EY-76-C-06-1830. 15p. Dep. NTIS, PC A02/MF A01.

Results of homogeneous catalytic hydrogenation of complex unsaturated substrates including coal and coal-derived materials are reported, with organic soluble molecular complexes as catalysts. Among the substrates used were Hvab coal, solvent-refined coal, and COED pyrolysate. The hydrogenations were carried out in an autoclave. The results are summarized in tables.

55556 (FE—2034-7) **Catalytic hydrogenation of coal-derived liquids. Interim report, March 1977—May 1977.** Berg, L.; McCandless, F.P. (Montana State Univ., Bozeman (USA)). Jun 1977. Contract EX-76-C-01-2034. 98p. Dep. NTIS, PC A05/MF A01.

It is the object of this research to convert coal to clean distillate fuels. This program will be limited to research on the product from existing coal liquefaction processes. Liquefied coal will be converted by a catalytic hydrogenation at elevated temperatures and pressures. Samples of the products from PAMCO, H-Oil, COED, and SYNTHOIL will be obtained. They will be heated and pumped, with and without solvent, into a catalytic reactor in the presence of hydrogen and other reducing gases. Variables to be investigated will include temperature, pressure, space velocity, hydrogen-to-oil ratio, chemical nature of the solvent. The catalysts to be studied will include nickel molybdate and sulfide, nickel tungstate, and other combinations on carriers such as mordanites and other molecular sieve types. Nineteen batch and seven continuous runs on SRC Vacuum Flash Feed are reported with denitrogenation up to 38 percent and desulfurizztion up to 75 percent achieved. On COED Pyrolysis Oil, eight batch and four continuous runs are reported with denitrogenation up to 45 percent and desulfurization up to 90 percent accomplished. Twenty-eight batch and nine continuous runs on SYNTHOIL are reported with denitrogenation up to 32 percent and desulfurization up to 48 percent attained. Shell's No. 344 cobalt molybdate catalyst gives 48 percent desulfurization, 32 percent denitrogenation, and 50 percent conversion to distillate material from SYNTHOIL. It gives 65 percent desulfurization and 30 percent denitrogenation with SRC and 88 percent desulfurization and 20 percent denitrogenation with FMC tar.

55557 (FE—2334-5) **Phase equilibria in coal hydrogenation systems. Quarterly report, April 1977—June 1977.** Kobayashi, R. (Rice Univ., Houston, Tex. (USA). Dept. of Chemical Engineering). 1977. Contract EX-76-S-01-2334. 8p. Dep. NTIS, PC A02/MF A01.

The objective of this research is to investigate the thermodynamic properties of chemical mixtures in coal hydrogenation systems and to provide fundamental information for process development and equipment design in coal liquefaction plants. Specifically, the proposed research is to measure vapor-liquid equilibria including K-values, dew point, and hydrogen solubility in polyaromatic and hetero-polyaromatic components and their mixtures. The phase equilibria studies and determination of K-values will be made using a gas-liquid perturbation chromatography technique. Preparation of ultra-high purity materials for these equilibria studies will be accomplished with new zone refining apparatus. Purity will be established by freezing point depression determination. High purity materials for the K-value and solubility studies are needed because of the extreme sensitivity of physiochemical properties to composition, particularly when structural dissimilarities are involved. H_2 solubility in coal components and mixtures will be measured via specially designed apparatus combining an equilibrium cell with a high precision transfer pump. In addition to providing broad range solubility data, this apparatus will allow the determination of extrapolative K-values to pure H_2 and polyaromatic systems. The same apparatus can also be used to yield equilibrium liquid phase, P-V-T, and vapor pressure data. Dew points of simulated and actual mixtures from coal hydrogenation processes will be measured to provide additional data for K-value evaluation. The data obtained from the experimental studies will be statistically evaluated and correlated to maximize its usefulness.

55558 (ORNL—5213) **Hydrocarbonization process evaluation report. Volume II. Evaluation of process feasibility.** Holmes, J.M.; Dyslin, D.A.; Edwards, M.S.; Joy, D.S.; Peterson, G.R. (Oak Ridge National Lab., Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 59p. (ORNL—5212(Vol.2)). Dep. NTIS, PC A04/MF A01.

Volume II of a two-volume study concerning the preliminary design and economic evaluation of a Hydrocarbonization Facility includes: (1) a review of the current status of the major processing units, (2) an assessment of operating problems, (3) considerations of possible process alternatives, (4) an evaluation of the overall process feasibility, and (5) recommendations for future process development. Results of the study emphasize the need for testing the evaluated process, which is based on the Clean Coke Process, in a continuous pilot plant using a wide variety of highly caking bituminous coals as feed material. A program suggested for the pilot plant would encompass: (1) development of improved methods for the prevention of agglomeration of highly caking coals during hydrocarbonization, (2) optimization of the yields of coal liquids, (3) investigation of a single-stage high-temperature hydrocarbonizer optimized for char production, and (4) optimization of beneficiation ratios employed during coal preparation.

GASIFICATION

REFER ALSO TO CITATION(S) 55611, 55634, 55635, 55684, 55722, 55756, 55985, 55987, 55988, 55989, 55990, 55992, 56609, 56962, 56966

55559 (CONF-760885—, pp 254-256) **Rapid devolatization of pulverized coal in hot combustion gases.** Ubhayakar, S.K.; Stickler, D.B.; vonRosenberg, C.W. Jr.; Gannon, R.E. (Avco Everett Research Lab., Inc., MA). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

An experimental and analytical study on the rapid devolatilization of pulverized bituminous coal injected and entrained in hot combustion gases flowing in a constant cross-section gasifier is presented. Data on the weight loss through rapid pyrolysis, on the temperature of the heterogeneous medium, and on the composition of the overall products are correlated with an analytical model incorporating two volatile-producing competitive first-order Arrhenius reactions followed by cracking of the volatiles. The experimental parameters are the mass fraction of coal fed into the combustion gases (0 to 0.12), the input gas temperature (1800 to 2250°K), three particle size distributions for the same type of coal, and the residence time in the gasifier (7 to 70 ms). All data pertain to tests conducted at a pressure of one atm. Heating rates up to 10^5 °K/s and volatile product yields up to 68% of the original dry, ash-free coal are observed. Analysis of the data suggests that a significant fraction

of these volatiles crack to soot and hydrogen, and that the cracking fraction increases with the coal fraction in the input gases. The fraction of the volatiles which crack in the gas phase vs. those which crack within the particles is deduced by correlating the analytical model with the data.

55560 (CONF-770510—6) **Problems solved and problems not solved in UCG.** Gunn, R.D. (Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center). 1977. 18p. Dep. NTIS, PC A02/MF A01.

From American Chemical Society meeting; Montreal, Canada (May 1977).

Fifteen major technical problems associated with UCG are discussed. Ten problems have been largely solved, five remain unsolved. Of the five, it is believed that only two, subsidence and excessive water influx, can present potentially major obstacles to commercialization of UCG. The Laramie Energy Research Center has had virtually no field experience with either problem because they become major ones only with large well patterns which have yet to be field tested. However, proposed large area field experiments should determine within the next few years whether these two problems can be resolved favorably.

55561 (CONF-770510—7) **Investigation of aromatic fractions from coal tar produced by an underground coal gasification test.** King, S.B.; Guffey, F.D.; Gardner, G.W. (Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center). 1977. 6p. Dep. NTIS, PC A02/MF A01.

From American Chemical Society meeting; Montreal, Canada (May 1977).

Analysis of an aromatic fraction from a coal tar produced from an underground coal gasification test shows mostly methylated naphthalenes, anthracenes, and phenanthrenes. The similarity between various aromatic fractions and the corresponding similarity of acid, base, and aliphatic fractions suggests that the liquid product is very constant in composition with respect to time. This would in turn indicate that the LVW process approaches steady state conditions. The constancy of such a product would certainly be compatible and desirable with any facility that might utilize such a liquid for either a feedstock or as a fuel. The lack of evidence for any PNA's in the aromatic fraction is certainly encouraging from an environmental standpoint and would probably be expected when considering the way in which the coal tar is produced. As a by-product, the coal tar appears to be a desirable product which only enhances the outlook for underground coal gasification becoming a commercial process.

55562 (CONF-770510—8) **Report on the successful development of underground coal gasification at Hanna, Wyoming.** Fischer, D.D.; King, S.B.; Humphrey, A.E. (Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center). 1977. 18p. Dep. NTIS, PC A02/MF A01.

From American Chemical Society meeting; Montreal, Canada (May 1977).

Hanna II yielded several outstanding accomplishments in the field of UCG using air injection. These were the following: production of the highest gross heating value product gas over the longest duration ever reported; operation at the highest thermal efficiencies ever reported; highest production rate from any UCG test in the Free World; high overall sweep efficiency for parallel two-well patterns; and the most thoroughly instrumented UCG test ever conducted. Based on the results of Hanna II, a large number of predicted problem areas attributed to in-situ coal gasification technology do not appear to be of significance. Stable operation at high production rates with relatively constant gas quality and composition have been achieved. Overall process and thermal efficiencies were high and resource recovery was excellent. No detectable gas leakage occurred based on nitrogen and argon balances. No shutdown due to equipment or process failure was encountered. Process control based on adjustment of air injection rate to maintain the optimum air/water ratio appears feasible. Further tests planned at Hanna will concentrate on further demonstration of these conclusions and will address the major unknowns still associated with the in-situ coal gasification process, i.e., the effects of subsidence and the determination of optimum and maximum well spacings.

55563 (CONF-770655—1) **Coal pressurization and feeding use of a lock hopper system.** Lewis, R.; Santore, R.R.; Dubis, D. (Energy Research and Development Administration, Pittsburgh, Pa. (USA). Pittsburgh Energy Research Center). Feb 1977. 12p. Dep. NTIS, PC A02/MF A01.

From Coal feeding systems conference; Pasadena, California, United States of America (USA) (21 Jun 1977).

A necessary preliminary step in the Synthane high-pressure coal gasification processes is to take ground coal at atmospheric pressure and feed it to the gasification system at operating pressure. A decision was made to use lock hoppers at Synthane. Accordingly, a proprietary system was purchased from Petrocarb, Inc. This system was designed to feed coal at pressures up to 1000 psig at rates of 1.67 to 5.0 tons/hr. This report discusses some of the specific problems experienced with the operation of the Petrocarb system at the Synthane Pilot Plant. It will also review the modifications made to improve its performance. The Synthane gasifier has been operated periodically from July, 1976 to the present time (January 31, 1977). More than 750 tons of coal have been fed to it through the Petrocarb system. Including functional tests, this represents approximately 1000 cycles on the single train and 500 cycles on the dual train portions of the system. The performance of the unit is considered satisfactory. With certain limitations it can be depended upon to feed coal to the gasifier within the design feed range. For a system of this degree of mechanical complexity, maintenance is reasonable. Major problems encountered during the initial testing and operation have been eliminated. Brief interruptions of coal feed will probably continue to occur occasionally due to the difficulty of completely eliminating minor breakdowns.

55564 (CONF-770814—3) **High- and low-Btu gas from Montana subbituminous coal.** Arora, J.L.; Burnham, K.B.; Tsaros, C.L. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. 23p. of Gas Technology, Chicago, IL.

From American Chemical Society meeting; Chicago, Illinois, United States of America (USA) (29 Aug 1977).

The manufacture of pipeline-quality gas by the Hygas Process shows a definite advantage over its manufacture by a single-stage, lower pressure system. Although the hydrogasifier is more complex and operates at a much higher pressure than the U-Gas reactor (1165 vs. 335 psig), a much greater amount of methane is made in the Hygas reactor. This gives large savings in coal, oxygen, and upgrading costs, resulting in a lower gas price and higher efficiency. When a low-Btu fuel gas of low methane content is satisfactory, the simpler, low-pressure U-Gas Process shows economic and efficiency advantages.

55565 (COO—2904-4) **Chemical and physical stability of refractories for use in coal gasification. First annual progress report, May 1, 1976—April 30, 1977.** Rahman, S.F.; Day, D.E. (Missouri Univ., Rolla (USA)). 20 May 1977. Contract EY-76-S-02-2904. 71p. Dep. NTIS, PC A04/MF A01.

This project commenced on 1 May 1976 with the objective of (a) achieving an understanding of the general types of chemical reactions occurring in refractories when exposed to conditions representative of those at the cold face of the refractory lining in coal gasification vessels, (b) assessing the relative importance of these reactions to those physical/chemical properties required for long-service life, and (c) identifying those refractory systems providing optimum service performance, particularly in regard to the bond phases. The basic aim of the investigation is to establish the corrosion resistance of refractories, especially the bond phases, to high pressure/temperature gas and liquid environments encountered in coal gasification. This annual report summarizes all of the data obtained and analyzed during 1 May 1976 to 30 April 1977. Portions of the tables in this report are incomplete since analysis of the exposure test results is still in progress.

55566 (ERDA—77-51) **Underground coal gasification program.** (Energy Research and Development Administration, Washington, D.C. (USA)). Mar 1977. 32p. Dep. NTIS, PC A03/MF A01.

This publication provides a brief overview of the Energy Research and Development Administration's (ERDA) program to develop underground coal gasification (UCG) technology. The UCG program is part of ERDA's overall strategy to create energy choices for the future. Since UCG technology is not widely known, even to the technical community, general descriptions of the concept and its potential applications are included. For the reader interested in more detailed coverage, a three-volume set will be available: (1) Management Plan; (2) Technical Data Book; (3) Resources. The objective of ERDA's UCG program is to develop commercially viable, underground gasification processes for extracting energy from coal. Through government and industry joint participation, the technology will be developed, proved on a large scale, and transferred to the private sector; data will be provided to predict the economics of a commercial operation. ERDA's objectives and its support of national energy goals are shown.

55567 (FE—1207-29) **Gas generator research and development: BI-GAS process. Quarterly report, January—March 1977.** (Bituminous Coal Research, Inc., Monroeville, Pa. (USA); Phillips Petroleum Co., Homer City, Pa. (USA)). Apr 1977. Contract EF-77-C-01-1207. 76p. Dep. NTIS, PC A05/MF A01.

Progress achieved during the period January to March 1977 on the general program, Gas Generator Research and Development, being conducted by Bituminous Coal Research, Inc. is presented. The continuing objective of this program is to develop processes for gasifying coal to produce high-Btu pipeline gas. Laboratory-scale coal gasification experimentation is to be conducted concurrently with a process and equipment development unit (PEDU). With the aid of engineering subcontractor(s), a BI-GAS pilot plant facility has been designed and constructed. Startup of this facility is in progress. The combined bench-scale and PEDU studies will be conducted to

develop a fluidized-bed methanation process for use in upgrading a coal-derived synthesis gas. At the bench-scale level, catalysts will be investigated under conditions imposed by the BI-GAS process. These conditions include high carbon monoxide concentrations, high pressure, and a 3/1 hydrogen to carbon monoxide ratio. The PEDU, which is a 6-inch diameter reactor designed for 6000 scfh ($CO + H_2$), will generate process data applicable to BI-GAS pilot plant operations. Utilizing the experience accumulated in laboratory and PEDU research, BCR will assist in planning, acquisition, and assessment of pilot plant operation data.

55568 (FE—1521-51) **Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant. Phase II. Quarterly technical progress report, April—June 1977.** Smith, D.E. (Foster Wheeler Energy Corp., Livingston, N.J. (USA)). Jul 1977. Contract EX-76-C-01-1521. 6p. (FWC/FWEC/GQ—09). Dep. NTIS, PC A02/MF A01.

A summary of the technical progress resulting from work during the period April-June 1977 toward the design and development of a combined cycle/coal gasification pilot plant is presented. The objective of this program is to develop, design, construct, and operate a pilot plant to produce clean low-Btu fuel gas from coal. Based upon a revised work plan, Foster Wheeler Energy Corporation (FWEC) has submitted to ERDA the final copies of Volumes 1, 2, 4, 7, 8, 9, 10, and 11 of the Design Report. This report contains all the process and mechanical design work completed to date.

55569 (FE—1775-10) **Preliminary design services, coal conversion demonstration plants. Research and development report No. 114. Quarterly report, January—March 1977.** (Parsons (Ralph M.) Co., Pasadena, Calif. (USA)). May 1977. Contract EX-76-C-01-1775. 42p. Dep. NTIS, PC A03/MF A01.

The objective is to develop preliminary designs and economic evaluations for a number of types of coal conversion plants. The following designs are included in the scope of work: conceptual commercial plant for a coal-oil-energy-development (COED) plant; oil/gas plant to produce liquid fuels plus substitute natural gas (SNG); commercial-scale Fischer-Tropsch plant with motor fuel and SNG as the main products; coal conversion plant to produce power, oil, gas, and other products (POGO); and facilities complex capable of demonstrating the commercial feasibility of a variety of coal conversion processes that show promise during pilot plant operations. The facilities will be considered for conversion of coal to: low- to -high-Btu fuel gas; methanol/motor fuel by Fischer-Tropsch process; and clean liquid fuels by alternate liquefaction processes. In addition, supporting efforts will be provided for the above activities. These efforts include planning and progress monitoring, equipment development, construction materials development, and environmental factors.

55570 (FE—2024-4) **Economic comparison of two BIGAS coal gasification processes.** Manthos, G.J.; Ellington, E.E. (Purvin and Gertz, Inc., Dallas, Tex. (USA)). Mar 1977. Contract EF-77-C-01-2024. 23p. Dep. NTIS, PC A02/MF A01.

The economics are compared of two similar coal gasification processes, Bigas and modified Bigas, which operate at 1,200 psig and 470 psig, respectively, to produce 250 billion Btu's per day of synthetic natural gas. The report has eight tables containing plant investments, maintenance costs, operating costs and resulting product gas cost. The figures included show block flow diagrams for the two processes. Conclusions answer the question whether it is more economical to produce as much methane as possible in the gasifier or in the methanator.

55571 (FE—2046-1) **Dew points of hot gases from coal gasification processes. Quarterly report, June 1—August 31, 1976.** Prausnitz, J.M. (California Univ., Berkeley (USA)). 1976. Contract EX-76-C-01-2046. 3p. Dep. NTIS, PC A02/MF A01.

The long-range purpose of this research is to obtain fundamental physicochemical data which, when coupled with theoretical results from molecular thermodynamics, will enable calculation of dew points in tar-containing gas mixtures at advanced temperatures and pressures. Experimental apparatus for measurement of dew-point data has been designed and, in part, constructed. Theoretical work toward data interpretation and correlation has been initiated.

55572 (FE—2046-2) **Dew points of hot gases from coal gasification processes. Quarterly report, September 1—November 30, 1976.** Prausnitz, J.M. (California Univ., Berkeley (USA)). 1976. Contract EX-76-C-01-2046. 4p. Dep. NTIS, PC A02/MF A01.

The long-range purpose of this research is to obtain fundamental physicochemical data which, when coupled with theoretical results from molecular thermodynamics, will enable calculation of dew points in tar-containing gas mixtures at advanced temperatures and pressures. Apparatus for measuring dew points has now been constructed. Preliminary efforts toward making the apparatus operational are now nearing completion. Theoretical efforts for interpreting and correlating dew-point data are concentrated on statistical-mechanical and on kinetic theories. Relative advantages and disadvantages of both approaches are under consideration.

55573 (FE—2210-12) **Study of heat transfer through refractory lined gasifier vessel walls. Quarterly progress report, December 1976—February 1977.** Schorr, J.R. (Battelle Columbus Labs., Ohio (USA)). Mar 1977. Contract EX-76-01-2210. 34p. Dep. NTIS, PC A03/MF A01.

The design of refractory linings for coal gasification vessels is important to the reliable and cost-effective operation of the process. The objective of this program is to develop an empirically derived computer model suitable for use by the vessel designer to determine heat flow through multicomponent, refractory-lined gasifier vessel walls, so that the effects of parameters such as lining thickness, density, refractory composition, physical form, metal anchor spacing and configuration, and gas pressure and composition can be predicted. The program includes the design, construction, and operation of test apparatus for evaluating these parameters which influence heat flow through refractory lining materials.

55574 (FE—2229-4) **Surface structure and mechanisms of gasification catalyst deactivation. Annual report, February 1976—January 1977.** Reucroft, P.J.; Bradley, E.B.; De Angelis, R.J.; Sargent, G.A. (Kentucky Univ., Lexington (USA)). May 1977. Contract EX-76-C-01-2229. 91p. Dep. NTIS, PC A05/MF A01.

Characterization studies on SiO_2 and Al_2O_3 supported coprecipitated Ni catalysts are described. Catalysts contain 10, 20, 30, 40, and 50 wt% of Ni. Characterization techniques include ESCA, Auger spectroscopy, X-ray diffraction, and ir absorption spectroscopy. When allowance is made for shifts in binding energy produced by surface charge, it is observed that the initially observed ESCA spectra appear to be dominated by that of Ni silicate (in SiO_2 supported catalysts) and by that of Ni aluminate (in Al_2O_3 supported catalysts), ESCA peaks characteristic of NiO are observed in unreduced catalysts after Ar ion etching. ESCA peaks characteristic of Ni are also observed in reduced catalyst after Ar ion etching. Ir spectra have been obtained of catalysts exposed to synthesis gas tests. Some alumina-support catalysts have ir absorption indicative of adsorbed CH and CO species. Most spectra show carbonate absorption similar to that for unexposed catalysts but the carbonate coordination was altered as a result of synthesis gas exposure. The sulfided alumina-support catalyst has no carbonate absorption and the Ni is no longer in the form of NiO. Auger analysis of the surface chemical composition and surface inhomogeneity was carried out on the commercial catalysts. The major elemental constituents are O, Ni, Al, C, and Na. The surface inhomogeneity of Ni content was found to vary by as much as 20%. Computer coding of the single profile analysis technique to separate the particle size and microstrain contributions to the X-ray line broadening and to obtain the strain corrected particle size distribution functions was completed. Particle size distribution functions were obtained on as-received and sintered NiO supported catalysts. Determination of particle size distribution functions of reduced and passivated Ni samples has been initiated.

55575 (FE—2355-12(Rev.A)) **Coal gasification valves. Phase I. Component development test procedure.** Collins, D.S. (Consolidated Controls Corp., El Segundo, Calif. (USA)). Apr 1977. Contract EX-76-C-01-2355. 22p. Dep. NTIS, PC A02/MF A01.

A procedure is presented for conducting development tests of critical valve components of the 8-inch Task III coal gasification valve. These tests will subject the individual components to maximum operating environmental conditions and verify the adequacy of the design.

55576 (FE—2355-13) **Coal gasification valves. Phase I. Stress analysis report.** Yee, W. (Consolidated Controls Corp., El Segundo, Calif. (USA)). Dec 1976. Contract EX-76-C-01-2355. 106p. Dep. NTIS, PC A06/MF A01.

The purpose of this analysis is to verify the structural and thermal integrity of the 8-in. coal gasification valves Type I, II, III, and IV. The analysis is divided into three sections. The first is the substantiation of the inlet internal configuration; the second is the outlet; and the third is the gate attachments and miscellaneous items. The temperature in all cases is conservatively assumed to be at a steady state level of 2000°F internal wall temperature. The thermal stresses are independent of any structural stresses and are added algebraically to obtain the total stress. The valve will be in the closed position and assumed to be situated in the vertical upright position unless otherwise specified.

55577 (FE—2355-14) **Coal gasification valves. Phase I. Type III valve prototype test plan.** Collins, D.S. (Consolidated Controls Corp., El Segundo, Calif. (USA)). Dec 1976. Contract EX-76-01-2355. 23p. Dep. NTIS, PC A02/MF A01.

A plan is provided for development testing of the prototype 8-inch Type III Coal Gasification Valve. Tests include proof pressure, leakage, actuation, and operational (with test media at both ambient and operating temperatures).

55578 (FE—2355-15) **Coal gasification valves. Phase I. Design analysis report.** Yee, W. (Consolidated Controls Corp., El Segundo, Calif. (USA)). Dec 1976. Contract EX-76-C-01-2355. 74p. Dep. NTIS, PC A04/MF A01.

The following subjects are covered: spring design; weight calculation; center of gravity location; control actuator specifications; and valve flow coefficient. The report consists mostly of drawings and equations.

55579 (FE—2355-16) **Coal gasification valves. Phase I. Thermal analysis report.** Roberts, R.A. (Consolidated Controls Corp., El Segundo, Calif. (USA)). Dec 1976. Contract EX-76-C-01-2355. 54p. Dep. NTIS, PC A04/MF A01.

A description is presented of the thermal analysis of an 8-Inch Type III Control Valve 75835 being developed for a coal gasification system.

55580 (FE—2355-19) **Coal gasification valves. Phase I. Thermal analysis report, 8-inch, Types I, II, and IV valves.** Roberts, R.A. (Consolidated Controls Corp., El Segundo, Calif. (USA)). Jun 1977. Contract EX-76-C-01-2355. 36p. Dep. NTIS, PC A03/MF A01.

The purpose of the thermal analysis is to provide an external temperature profile of the valve body and a temperature gradient of the valve gate in the open position. The analysis was assumed to be a steady state condition. The analysis was performed by Mechanics Research, Inc. The results of the analysis are contained in their document number MRI-2101-TRI, which is included in the Appendix of this report.

55581 (FE—2356-20) **Stuffing box test procedure.** (Fairchild Industries, Inc., Manhattan Beach, Calif. (USA). Fairchild Stratos Div.). 23 Mar 1977. Contract EY-76-C-01-2356. 11p. Dep. NTIS, PC A02/MF A01.

An outline is presented of development tests to be performed upon stuffing box components in support of the development of lock-hopper valves for coal gasification processes. The purpose of the tests is to verify the soundness of stuffing box design (specifically, that of bearings and packings) or to indicate the modifications that will result in a sound design. The stuffing box to be tested differs from that of the actual lock-hopper valves only in that the inner shaft and associated components are deleted from the former.

55582 (FE—2370-13) **Coal mine-coal conversion plant interface evaluation and conceptual design. Phase II. Monthly technical progress report, 1 April—30 April 1977.** (Bechtel Corp., San Francisco, Calif. (USA)). Jun 1977. Contract EX-76-C-01-2370. 33p. Dep. NTIS, PC A03/MF A01.

Work performed during the period 1-30 April 1977 for a Coal Mine-Coal Conversion Plant Interface Evaluation and Conceptual Design is covered. Interface conceptual engineering and cost estimating are considered. In April, conceptual designs were completed for the two ICMC coal transport alternatives, conveyors and automated rail haulage (Modules 20 and 30). The conveyor facility consists of two conveyor lines in each ICMC mine and an intermine conveyor system. In-mine conveyors feed one of two storage bunkers. A single 72-in. conveyor line transports all coal to the surface. The automated rail haulage facility transports coal between conveyor-fed train loading stations located in each mine main entry to a central unloading station. From here coal is conveyed to the surface via a single 72-in. conveyor line. The automated trains do not run to the surface because of grade limitations. A limestone handling and receiving facility was incorporated into the Coarse Coal Feed Transport Facility that provides limestone for the atmospheric pressure fluidized-bed steam/gas generators that provide steam for power generation, process steam, and hot flue gas for coal drying and pulverizing. In the steam/gas generators, the limestone removes flue gas sulfur oxides. The rail transport section of the Regional Coal Mining-Remote Conversion Site alternative was concluded. Rail haulage accounts for approximately one-thirdof the coal transportion to the remote conversion plant generic location. Several problems exist, including a reluctance on the part of railroads for intrastate hauls. Interface cost estimating was initiated during this period. Both single-capacity capital cost estimates and capital cost-capacity scale factors are being developed.

55583 (ORNL—5312) **Feasibility study of prestressed concrete pressure vessels for coal gasifiers.** Greenstreet, W.L.; Oland, C.B.; Callahan, J.P.; Canonico, D.A. (Oak Ridge National Lab., Tenn. (USA)). 19 Jul 1977. Contract W-7405-ENG-26. 154p. Dep. NTIS, PC A08/MF A01.

Prestressed concrete pressure vessels (PCPVs) have potential for use as gasifier vessels in commercial-sized coal conversion plants. This was established through a study of two conceptual designs. Problem areas are identified, and a test program is defined for concept verification and performance examination and demonstration. The gasifiers considered are for two-train plants based on the HYGAS and the Synthane processes. The plant output was assumed to be 500 x 10^9 Btu/day for the HYGAS process and 250 x 10^9 Btu/day for the Synthane process. In preparing the designs, extensive use was made of existing developments for containment vessels. On the bases of the examinations made, it was concluded that the use of prestressed concrete gasifier vessels is both technically and economically feasible. A program of follow-up study is outlined to provide backup experimental data needed for support of this conclusion.

55584 (UCRL—5225) **Ground subsidence resulting from underground gasification of coal.** Gregg, D.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Mar 1977. Contract W-7405-ENG-48. 33p. Dep. NTIS, PC A03/MF A01.

Ground subsidence has been found to be a very significant physical phenomenon that must be dealt with in the design and operation of an underground coal gasification process. This report deals with the types of subsidence that one might expect, and how they affect the process. A brief theory of bending subsidence is presented, and the experience the Soviets had while operating their commercial underground gasification stations is reviewed.

55585 **Method of processing coal channels in underground coal gasification.** Kreinin, E.V. US Patent 4,024,914. 24 May 1977. Priority date 27 Dec 1974, Union of Soviet Socialist Republics (USSR). 4p.

A method of processing recently bored channels when putting into operation an underground gas generator (underground gasifier), consisting, on the one hand, in forced air blowing and, on the other hand, in taking away hot gases, is characterized by determining the magnitude of the hydrostatic pressure by measuring the hydrostatic column of underground waters in a vertical direction from the point at which air is forced into the well to the level of the underground waters, and adjusting the outlet section of the gas discharging wells. This permits maintaining in the boring channel a pressure at a level which is not less than that produced by the hydrostatic column to preclude an inflow of underground waters to the channel being processed. The temperature in the channel is raised at a rate from about 80 to about 100°C per hour up to at least 500°C. 2 claims, 3 figures.

55586 **Synthesis of substitute natural gas based on coal.** Hammer, H. (Tech Hochsch, Aachen, Ger). *Erdoel Kohle, Erdgas, Petrochem. Brennst.-Chem.;* 30: No. 3, 132-136(Mar 1977). (In German).

The present status in the development of processes for producing substitute natural gas (SNG) based on coal or lignite is discussed. The historical and theoretical background of the direct hydrogenating gasification of coal, as well as that of heterogeneous catalytic methanation of carbon monoxide is reviewed. Further, processes currently being developed, especially in the USA, UK and West Germany, are discussed. Since the manufacturing costs of coal-based SNG currently are about twice or three times higher than the prices of ordinary natural gas, there is still some hesitancy in the United States about going into production of coal-based SNG, despite the acute natural gas shortage there. In Europe, production of coal-based SNG will become a necessity in the long range, perhaps as early as the next decade. 21 refs.

55587 **Success at Westfield.** Gray, J.A. *Energy Dig. (London);* 6: No. 1, 39-43(Feb 1977).

In comparison with the Westfield coal, the US coals because of their low fusion point ash needed a higher steam/oxygen ratio to prevent sintering and produced a higher yield of liquor. Thee were other differences as well but the one important result of the trials was that American coals ranging from the subbituminous coals of the western US to highly caking coals of the mid-west and east, representing large and important reserves in the USA, could be successfully gasified in a Lurgi gasifier. In the conventional Lurgi gasifier, excess steam is required to avoid clinkering and the amount is greater if the ash is of low fusion point and the coal is of low reactivity. With slagging operation the steam is reduced to little more than that required for gasification, and at the higher temperature reactivity is of less significance. The reduction in steam is more than fivefold and this large decrease results not only in higher thermal efficiencies but also in greater throughput and reduced amounts of the liquor produced. Further international cooperation has led to the conversion of one of the gasifiers to slagging operations at Westfield with trials that showed crude gas production rates of about four or five times those of the original Westfield Lurgi gasifier with very much lower yields of gas liquor in runs of seven days duration.

55588 **Underground coal gasification.** Ledent, P. (Inst Natl des Ind Extr, Liege, Belg). *Rev. Energ.;* 28: No. 291, 89-101(Feb 1977). (In French with English abstract).

Two projects based on the use of pressures cyclically varying between a minimum of 20 to 30 bars and a maximum of 40 to 60 bars, are being studied in Western European research centers. The INIEX Projects (Liege, Belgium) is directed toward the production of a lean gas to supply a mixed-cycle power plant: gas turbine + steam turbine. The K.F.A. Project (Juelich, West Germany) is directed toward the production of a natural gas substitute through hydrogasification. These studies, which are being carried out on the basis of

international cooperation, are aimed at making Europe independent as far as its energy is concerned by exploiting its deep seated deposits which cannot be economically mined using conventional methods. 13 refs.

55589 Future of the coal byproducts industry. Boyer, A.F. (Charbonnages de Fr). *Rev. Energ.;* **28**: No. 291, 118-122(Feb 1977). (In French with English abstract).

A survey of the coal by-products industry based on coke and coking by-products. It yields hydrogen, aromatic hydrocarbons, phenols, and nitrogenous bases from tars and benzols. Only benzene and naphtalene are now of any real economic interest. The gradual substitution of solid fuels (coals or oil shales) for liquid hydrocarbons as a source of energy and of raw materials is inevitable owing to the difference in the existing reserves. Logically, coal should be substituted for petroleum first of all in the field of energy and then, and then only, in chemistry since it is easier, when it is possible, to work with petrochemistry. Nevertheless there are good deposits of coals which are too sulfurous to be burned, for which a profitable chemical use will have to be found for the deposit. It is concluded that the future prospects for the 1990s are: the installation of very large complexes for producing liquid hydrocarbons or rich gas through coal gasification or direct hydrogenation and the use of a fraction of the products leaving these plants for the chemical industry.

55590 (ERDA-tr—296) Status report at the end of the concept phase, 1 August 1975—30 November 1976. Dec 1976. Translated from pp 1-93 of Market and economic study on nuclear coal gasification. 96p. Dep. NTIS, PC A05/MF A01.

The objective of this study was to investigate whether the potential use and economic prospects of nuclear coal gasification justify the high developmental expenses for it, based on the technical knowledge attained in the concept phase of the project. Synthetic natural gas (SNG) was considered to be the product of nuclear coal gasification. The studies on the potential use of SNG were concentrated on the heat market in the Federal Republic of Germany, considering its expected development up to the year 2025. The gas production costs were determined for various nuclear gasification processes and compared with those of the Lurgi pressure gasification as an example of a conventional process, and with the heating prices of natural gas and light fuel oil. The economic advantage of nuclear coal gasification over petroleum and natural gas was determined, and compared with the developmental costs. The time available, though, did not allow a comprehensive cost-utility analysis. The potential use and heat costs of distant nuclear energy are investigated in a separate section. 1[illegible] references, 22 figures, 13 tables.

55591 Remote sensing of an underground coal-burn cavity with a wide-band induction system. Quincy, E.A.; Moore, D.F. (US ERDA, Laramie Energ Res Cent, Wyo). *IEEE Trans. Geosci. Electron.;* **GE-14**: No. 4, 236-244(Oct 1976).

A conducting cavity in an underground coal burn was remotely probed from the surface with a wide-band electromagnetic induction system. The cavity, located near Hanna, WY, was produced by underground gasification of a 30-ft-thick subbituminous-coal seam ranging in depth from 300 to 400 ft. The cavity filled with saline ground water after the burn. The wide-band loop-loop system employed pseudonoise and cross-correlation techniques to produce a transient-time response in the field. Additional computer processing produced normalized 3-dimensional signature maps in both the time and frequency domains. These horizontal profiling maps, corresponding to a 100-Hz-50-kHz passband, demonstrate that a significant anomaly is produced by the cavity as the system is moved across the site. Time-domain maps show nearly a 7-1 change in relative peak-to-peak values, whereas the frequency-domain magnitude response changes as much as 36-1. Results were corroborated using another single-frequency system. These anomalies demonstrate the feasibility of employing induction systems to characterize remotely underground coal-burn cavities filled with conducting fluid. 21 refs.

55592 Success at Westfield. Gray, J.A. *Coal Energy Q.;* No. 11, 15-22(1976).

The technology of coal-based substitute natural gas (SNG) has been proved by British Gas Corp. in collaboration with U.S. companies and West Germany's Lurgi company. The stages of this achievement are described, with special emphasis on the Lurgi gasifier and trials with American coals: These trials showed that the U.S. coals, ranging from the western subbituminous coals to highly caking coals of the midwest and east, could be successfully gasified in a Lurgi gasifier.

55593 Materials for steam gasification of coal with HTR heat. van Heek, K.H.; Wanzl, W.; Gala, A.; Kalwa, G. (Bergbau-Forsch, Essen, Ger). *Rev. Int. Hautes Temp. Refract.;* **13**: No. 4, 217-223(1976).

The concept and implementation of steam gasification of coal using high-temperature reactor process heat is described, and the principal research and development problems involved are discussed. Particular attention is given to the development and selection of suitable high-temperature alloys. 6 refs.

55594 ERDA demonstration plant program for high-Btu gas. Cochran, N.P. (ERDA, Washington, DC). *Am. Gas Assoc., Oper. Sect., Proc.;* No. 76-T-61, vp(1976).

From American Gas Association conference; Las Vegas, NV, USA (3 May 1976).

Program providing the data and the experience in applying advanced and improved synthetic fuel processes and technologies is discussed. The objective is to demonstrate, in cooperation with industry, the technical and operational feasibility as well as the reliability of coal utilization processes and to provide incentives to influence corporate management to proceed with demonstration of relatively high risk technologies, participate in management of demonstration projects, and to coordinate the demonstration plant method of accelerating advanced energy technologies with other Federal incentives for technology transfer.

LIQUEFACTION

REFER ALSO TO CITATION(S) 55557, 55558, 55582, 55589, 55621, 55634, 55635, 55641, 55643

55595 (CONF-760885—, pp 14-33) Petrographic composition of coals: its importance in liquefaction processes. Davis, A. (Pennsylvania State Univ., University Park). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

For many of the industrial uses to which coal is put, it has usually been sufficient to test the quality and behavior of samples by methods of chemical and physical analysis. There are several aspects of coal, however, for which it is necessary to regard coal as being a heterogeneous mixture of materials. In the hand specimen and under the microscope coal is seen to be composed of different rock types and entities. Since these various materials have been shown to have different physical and chemical properties their relative abundance fundamentally determines the overall properties which a coal may possess. The study of these materials, their origin, composition and technological importance is known as coal petrology. Coal petrography is the branch of that science which is particularly concerned with systematic studies of the microscopically recognizable components of coals. These studies have proved to be of great value in the field of coal utilization.

55596 (CONF-760885—, pp 34-39) Coal liquefaction by alkylation. Geigel, M.A.; Flores, R.A. 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

Anhydrous hydrogen fluoride catalyzed alkylations of Pittsburgh Seam (hvb) coal were studied using ethylene, propylene, and isobutylene. At 135°C and 400 psig propylene was found to be the better alkylating agent in that it yielded a product that was 70 percent soluble in THF and had a 25 percent greater heating value compared to the original coal. Alkylations using methanol, ethanol, isopropanol, 2-hexanol, and the isomeric butanols at 200°C and 1500 psig yielded products that were 54 to 69 percent soluble in THF, with the exception of methanol which yielded a product that was only 11 percent soluble. The greatest increase in heating value was obtained with s-butanol (18 percent).

55597 (CONF-760885—, pp 72-85) Spectral analysis of effluents from coal liquefaction processes. Schwighardt, F.K.; Sharkey, A.G. Jr. (Pittsburgh Energy Research Center). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

It is the goal of the Spectro-Physics section of ERDA-PERC, by applying advanced analytical techniques to the compositional analysis of coal-derived products, to determine the factors which influence coal utilization, further processing, catalyst deactivation, health hazards, and environmental considerations, and to gain a fundamental understanding of the chemistry of coal conversion.

55598 (CONF-760885—, pp 125-134) Application of field ionization mass spectrometry to the characterization of coal liquefaction products. Scolnick, M.E.; St. John, G.A.; Anbar, M. 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

Coal liquefaction development necessitates a thorough knowledge of the composition of the liquid products. This information is necessary for the assessment of the efficacy of the coal liquefaction processes and the understanding of their mechanisms, as well as for quality control. Coal liquefaction products are presently characterized by their solubility in a number of standard solvents of increasing polarity. Solubility provides some general information about the

chemical nature of the product. Hexane will, for instance, dissolve most of the hydrocarbons but very little of the heterocyclic compounds, many of which will dissolve in benzene. A more meaningful parameter is the molecular weight of the products. Field ionization produces molecular ions exclusively from most organic compounds. When a complex mixture is analyzed by field ionization mass spectrometry, there are obtained as many peaks as compounds, provided there are no isomers or isobars that share the same nominal molecular weight.

55599 (CONF-760885—, pp 144-164) **Chemistry of asphaltene in coal liquids.** Yen, T.F. (Univ. of Southern California, Los Angeles). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

Current coal liquefaction for converting solid coal into coal liquids consists of three major processes: staged pyrolysis, solvent refining, and catalyzed hydrogenation. In each of these liquids, the presence of asphaltene is ubiquitous. The importance of asphaltene in coal liquefaction can be summarized as: asphaltene is a transition intermediate from coal to both oil and coke; understanding the generation of asphaltene will help to eliminate the coke formation; heterocyclic atoms such as sulfur, nitrogen, and oxygen, tend to concentrate in the asphaltene fraction; and metals and ashes are apt to bind with asphaltene fractions.

55600 (COO—0056-4) **Synthoil hydrodynamics. Final report.** Brenner, H.; Prieve, D.C.; Fitch, B. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Dept. of Chemical Engineering). Mar 1977. Contract EY-76-S-02-0056. 11p. Dep. NTIS, PC A02/MF A01.

The objective of the research is to develop mathematical models to explain and correlate the experimental data concerning two-phase cocurrent upflow through packed beds, as found in the Synthoil reactor and the associated cold-model. Such correlations and understanding will be useful in scale-up as well as optimum design of the reactor.

55601 (EPRI—1234) **Status of Wilsonville Solvent Refined Coal pilot plant. Interim report.** (Southern Services, Inc., Birmingham, Ala. (USA)). May 1975. 131p. Dep. NTIS, PC A07/MF A01.

The Southern Company system and the Electric Power Research Institute are jointly sponsoring a pilot plant project to study key steps in the solvent refining process for making low-sulfur and low-ash solid fuel from coal. The pilot plant, located near Wilsonville, Alabama, was completed in 1973 and began operation with coal in January, 1974. The overall reliability of the pilot plant facility was demonstrated in sustained periods of operation of 45 and 75 days. However, the mechanical performance of certain equipment needs to be improved. The screens in the filter, which separates the dissolved coal solution from the mineral residue, have had a maximum service life of 20 days. Laminated screens may provide the greater strength required for longer service. Centrifugal pumps handling slurries of raw coal or filter aid materials showed excessive wear when ductile iron casings were used. Pump casings made of a high-chromium alloy or coated with a nickel-chromium alloy are giving improved service. Tungsten carbide trim is required in valves handling slurries. Persistent problems have been experienced with discharging dried mineral residue from the dryer used to recover solvent from the filter cake. The technical feasibility of the SRC process to produce solvent refined coal containing less than 0.96% sulfur and less than 0.16% ash from two types of coal over a range of operating conditions has been demonstrated. The inplications of the pilot plant operations for desirable reaction conditions are given.

55602 (FE—1517-24) **Evaluation of valves for Cresap testing.** Hariram, S.S. (Fluor Engineers and Constructors, Inc., Los Angeles, Calif. (USA)). Mar 1977. Contract EX-76-C-01-1517. 49p. Dep. NTIS, PC A03/MF A01.

Results are presented of studies undertaken for testing various valve designs and other related piping components at the Cresap Pilot Plant to develop coal liquefaction plant design technology. After due consideration of the problems associated with coal liquefaction, it was decided that certain valve types and designs used with considerable success in past related plant operations be tested. The valves selected represent some of the major valve types—gate, globe, check, and plug. Other related piping components selected for testing are a Rod-Out Device and a High Pressure Connector. These piping components were considered for testing based on slurry and pressure requirements inherent with the coal liquefaction process.

55603 (FE—1752-14) **Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. The role of synthetic liquids from coal in meeting future energy demand. Final report, January 1975—December 1976.** Candela, B.J.; Brown, W.M. (Hudson Inst., Inc., Croton-on-Hudson, N.Y. (USA)). May 1977. Contract EX-76-C-01-1752. 71p. Dep. NTIS, PC A04/MF A01.

This task attempts to determine the likely production of synthetic liquid fuels from coal in order to meet future domestic requirements for petroleum products. For this purpose it was necessary to project the world supplies of conventional petroleum over time, and the domestic production. These projections coupled with estimates of demand determine the gap to be filled. Future demand—as affected by conservation and technological alternatives to conventional petroleum—is examined is some detail. Two projections are then made of domestic supply and the demand for conventional petroleum products. These enable estimates to be made of a reasonable balance between liquid synthetics over time and imported fuels—a balance designed to reduce dependence upon imports during and after the mid-1990s. Considerable uncertainty is inherent within the estimates because of the importance of future technological innovation, changing world reserves, and the relevant economics. For a relatively surprise-free projection it appears that between 200 and 400 plants of (nominal) 50,000-barrel-per-day capacity might eventually be required.

55604 (FE—1752-15) **Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Ownership issues: alternative structures for creating a commercial coal liquefaction industry. Final report, January 1975—December 1976.** Green, H.P.; Barron, J.A. (Hudson Inst., Inc., Croton-on-Hudson, N.Y. (USA)). May 1977. Contract EX-76-C-01-1752. 90p. Dep. NTIS, PC A05/MF A01.

This study is an inquiry into the various ownership and financing roles that the government might fulfill in the establishment of a large-scale coal-liquefaction industry. It first analyzes various historical precedents to determine their potential applicability to the present situation. Then various alternatives from totally private ownership to totally public ownership are examined to assess their advantages and disadvantages including the possibility of changes in ownership over time. The analysis generally finds that where government involvement is important the structuring of the operations should be made as much as possible like that of a private corporation and avoid involvement with civil service laws. Finally, the involvement of government in this new industry is expected to decrease over time--in part through a transfer of its ownership, if any, of facilities acquired during the early phases.

55605 (FE—1752-16) **Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-1. Environmental considerations affecting the development of a coal liquefaction industry. Final report, January 1975—December 1976.** Vietor, R.H.K. (Hudson Inst., Inc., Croton-on-Hudson, N.Y. (USA)). May 1977. Contract EX-76-C-01-1752. 76p. Dep. NTIS, PC A05/MF A01.

The principal environmental problems of a potential coal-liquefaction industry are associated with land restoration, hydrological balance in aquifers, solid-waste disposal, water emissions, and gaseous effluents. These problems and available or potential solutions to them are assessed. Where specific standards exist it is expected that the technology will be able to meet the requirements except for the unrealistic 1985 goal of "zero" water effluent discharges and the "no significant deterioration" standards for air quality. Where standards are not specific the resolution of problems is more obscure and tends to become political. The ultimate resolution will probably depend upon a balance between the percieved need for the energy and the desire for increasing environmental purity.

55606 (FE—1752-18) **Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-3. Availability of water for the development of a coal liquefaction industry. Final report, January 1975—December 1976.** Candela, B.J.; Thomas, J.; Brown, W.M. (Hudson Inst., Inc., Croton-on-Hudson, N.Y. (USA)). May 1977. Contract EX-76-C-01-1752. 60p. Dep. NTIS, PC A04/MF A01.

This study examines the problems associated with providing the water needs of future hypothetical coal liquefaction plants in various parts of the U.S. All potential sources that could furnish several million gallons per day (mgpd), or more, are examined including local surface water, fresh ground water, brackish or saline water (including desalinization), recycled wastewater, and imported (pipeline) water. Using a standard (i.e., maximum) requirement of 10 mgpd for a nominal commercial plant (producing 50,000 barrels/day) all regions examined were found to be able to supply the required water one way or another. The worst situation examined was that for western plants in the Four Corners region. There the most costly solution, water transported 1000 miles from the Missouri, would add about 60 cents per barrel of synthetic oil—compared to about 20 cents per barrel for desalinization of local ground water, the second most costly option. In most regions relatively low-cost water appears to be available. Where costs are relatively high engineering design options can reduce the standard water requirements by 50-80 percent, at some increase in capital investment.

55607 (FE—1752-20) **Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-5. Manpower requirements. Final report, January 1975—December 1976.** Thomas, J. (Hudson Inst., Inc., Croton-on-Hudson, N.Y. (USA)). May 1977. Contract EX-76-C-01-1752. 64p. Dep. NTIS, PC A04/MF A01.

The problem of the timely availability of sufficient engineering, construction and operational manpower for the development of a large-scale coal-derived synthetic liquids industry is examined. The numbers of "standard" 50,000 bpd plants are postulated through a family of scenarios over a period from 1975 through 2025, and the engineering and construction manpower requirements to build them are calculated. Similarly, operational manpower requirements are established as plants come on line. The cumulative requirements are measured against projected availability of manpower in the categories of interest and the potential effect of such an industry on the U.S. labor market is examined. It was determined that a phased addition of a coal-derived synthetic liquids industry on the existing industrial infrastructure is unlikely to have significant adverse effects.

55608 (FE—1752-21) **Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Economic issues affecting the development of a coal liquefaction industry. Final report, January 1975—December 1976.** Brown, W.M.; Hudson, M.; Kahn, H. (Hudson Inst., Inc., Croton-on-Hudson, N.Y. (USA)). May 1977. Contract EX-76-C-01-1752. 92p. Dep. NTIS, PC A05/MF A01.

Because a coal-liquefaction industry is in its embryonic stage, a number of economic issues exist that are relevant to its birth, its growth, and to its long-term viability. Given the need to reduce our dependence upon OPEC, the initial prototypes for a coal-liquids industry are being supported by ERDA; but the transfer of responsibility for commercial development and subsequent growth to private industry will require considerable economic assistance from the government as long as the financial risks appear to be substantial, as they now do. The government's intrinsic involvement is so pervasive that its policies will have an enormous impact on the economics of this potential new industry and, indeed, could enable it to become competitive with imported oil. The important potential actions that can be taken by the government are: (1) to furnish the needed subsidies and guarantees to launch the infant industry in the near term; (2) to reduce the capital charges per unit of output by minimizing the cost of borrowed funds through Federal guarantees and permission to use inflation-corrected accounting and indexed bonds; (3) to reduce the cost of raw materials by making Federal coal available at or near its extraction costs; (4) to encourage the development of the industry by initial GOCO (government-owned, company-operated) arrangements that subsequently can be transferred to the private sector; and (5) to make mobilization preparations which would allow a rapid increase in the coal-liquefaction capacity, should the need for such action arise.

55609 (FE—1800-12) **Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels. Quarterly report, December 1976—February 1977.** Cronauer, D.C.; Lopez, J.; Wynne, F.E. (Gulf Research and Development Co., Pittsburgh, Pa. (USA)). [nd]. Contract EX-76-C-01-1800. 94p. Dep. NTIS, PC A05/MF A01.

This quarterly report describes third quarter activities in this program for research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels. Exploratory atmospheric pressure and incrementally charged pressure coking studies scheduled under Task 2 have been largely completed and available results are reported as are continuing hydrogen transfer mechanism studies. Slurry physical properties and critical decomposition zone studies have been started and preliminary results are discussed.

55610 (FE—2031-7) **Chemistry and structure of coal-derived asphaltenes, Phase II. Quarterly progress report, January—March 1977.** Yen, T.F. (University of Southern California, Los Angeles (USA)). 1977. Contract EX-76-C-01-2031. 39p. Dep. NTIS, PC A03/MF A01.

Separations of Synthoil liquefied coal by solvent fractionation and high pressure liquid chromatography have been compared. Solvent fractionation is believed to give more distinctive fractions. The asphaltene fraction obtained by use of hplc was found to be a mixture of resin, asphaltene, carbene, and carboid. Solvent elution chromatrogrphy of asphaltenes on silica gel has been scaled up, and recoveries of 98-99 wt. % are generally obtained. VPO molecular weight studies of coal asphaltenes, as a function of concentration, in the solvents benzene and THF indicate that association of asphaltenes takes place in both solvents, but is more significant in benzene. Structural parameters obtained from modified Brown-Ladner treatment of proton NMR data suggest that solvent fractions: oil, resin, asphaltene, and carboid have structural characteristics which are sequentially related. X-ray diffraction patterns for asphaltene, carbene, and carboid fractions reveal progressively sharpened (002) and (11) bands indicative of increasing carbonization in this series. Methyl iodide addition to a basic fraction of Synthoil asphaltene (diethyl ether-eluted from silica gel) suggests, in conjunction with infrared results, that essentially all of the nitrogen in this fraction is present in basic pyridine-like compounds.

55611 (FE—2247-1) **Gasification of residual materials from coal liquefaction. Quarterly report, October—December 1976.** Robin, A.M. (Texaco, Inc., Montebello, Calif. (USA). Montebello Research Lab.). Jan 1977. Contract EX-76-C-01-2247. 12p. Dep. NTIS, PC A02/MF A01.

Almost all coal liquefaction processes, which are being developed to reduce our dependence on foreign oil, require hydrogen or synthesis gas to solubilize the coal. In order to obtain a favorable product yield in such a coal liquefaction plant, it is necessary to produce the needed hydrogen or synthesis gas primarily from the non-liquefied fraction of the coal. This material, together with the inorganic ash and some fraction of the converted coal, may be recovered in various forms depending on the particular process. Many of these waste materials will make excellent feedstocks for gasification using the Texaco Coal Gasification Process and two such materials have been evaluated for this potential application. The "Syncrude Vacuum Tower Bottoms" obtained from the H-Coal liquefaction of Illinois No. 6 coal appears to be a suitable candidate feedstock, but the "Settler Stripped Underflow" from the H-Coal liquefaction of Illinois No. 6 coal is a poor candidate because of its physical characteristics.

55612 (FE—2251-14) **Conceptual design for advanced coal liquefaction commercial plant. Quarterly technical progress report, August 1—October 31, 1976.** (Fluor Engineers and Constructors, Inc., Irvine, Calif. (USA)). Dec 1976. Contract EX-76-C-01-2251. 72p. Dep. NTIS, PC A04/MF A01.

The objective of this contract is the preparation of a conceptual design package for a commercial facility to produce liquid synthetic fuels by an advanced coal liquefaction scheme. The liquefaction process is of the hydrogen donor solvent type (CSF Process). This is the second Quarterly Progress Report under this contract and covers work performed during August, September, and October, 1976. Results presented in this report represent the status of work on this project as of the end of the second quarter. Some of the conclusions presented are different from conclusions set forth in the previous Quarterly Report due to the acquisition of additional information and to additional analysis. Likewise, some of the conclusions presented herein are subject to change during the ensuing periods if so indicated by new information. Task 1010 has been almost completed, thereby establishing the basis for final design. The majority of effort has been devoted to this task. In addition, significant effort has been devoted to Task 1050, Plant Sizing Rationale and to Task 2030, Mine and Plant Site. Also, work has begun on Task 1020, Process Design, on Task 1040, Additional Data Requirements, and on Task 1050, Plant Sizing Rationale.

55613 (FE—2550-2) **Physical and chemical behavior of liquefied coal in solids separation. Quarterly report, January—March 1977.** Briggs, D.E.; Addington, D.V.; Cameron, J.R. (Michigan Univ., Ann Arbor (USA). Dept. of Chemical Engineering). Apr 1977. Contract EX-76-S-01-2550. 47p. Dep. NTIS, PC A03/MF A01.

Bis-(o-hydroxyphenyl)-alkanes and bis-hetrocyclic compounds were synthesized with some success although continued work on synthesis and purification are needed to provide model asphaltene compounds. Mixtures of pyridine and phenol were examined to determine the O-H-N hydrogen bonding contribution to the NMR spectra of asphaltenes. Samples of seven asphaltene fractions, which had been separated in a 10.16-cm ID x 122-cm long preparative scale GPC column, and a preasphaltene fraction were characterized by molecular weight, elemental and proton NMR analyses. The molecular weight distribution in four asphaltene fractions was also determined. The fractions will be used in adsorption, viscosity, and colloid chemistry work. The filtration equipment was modified to decrease the time needed for an experimental run and to increase the accuracy of measurements. An experimental procedure to measure the size-configuration of asphaltene colloids by small angle X-ray scattering was developed. Experimental equipment to measure the electric conductivity and dielectric constants of asphaltene solutions was put into operation. Some data were obtained on asphaltenes in benzene. Adsorption characteristics of four narrow molecular weight asphaltene fractions were examined. The analysis included the effects of temperature, solvent, and solid adsorbent.

55614 (NP—22092) **Coal liquefaction: technology, impacts, and technical suitability for Montana.** McBride, J.R. (Montana Energy Advisory Council, Helena (USA)). Sep 1976. 87p. Energy Advisory Council, Helena, MT.

The technology of coal liquefaction and its associated impacts are reviewed. The report relies almost solely on secondary sources and is by no means all-encompassing. It is an attempt, however, to begin to bring together existing sources related to the technology of coal liquefaction. Coal liquefaction is a rapidly expanding research

area, but also an area plagued by numerous uncertainties. As a result, literature only a year or two old may be outdated and essentially useless. For this reason, the report relies heavily on a few very recent reports and review articles, although the older literature was reviewed particularly for process descriptions. Of particular utility were reports prepared by the Stanford Research Institute, the Radian Corporation, and Tetra Tech, Inc., cited in the Bibliography of this report. The general schematics used to illustrate the major categories of coal liquefaction in the text are from Cochran's recent review article in Scientific American and Energy From Coal, prepared by Tetra Tech Inc., also cited in the bibliography.

55615 (ORNL—5209(Vol.1)) **Evaluation of the Synthoil process. Volume I. Process design and economic evaluation of a 100,000-barrel/stream day facility.** Salmon, R.; Edwards, M.S.; Ulrich, W.C. (Oak Ridge National Lab., Tenn. (USA)). Jun 1977. Contract W-7405-ENG-26. 228p. Dep. NTIS, PC A11/MF A01.

A conceptual process design and a cost estimate for a 100,000-bbl/day Synthoil facility are presented. The design was based on experimental data obtained at Pittsburgh Energy Research Center and uses an operating pressure of 4000 psig in the reaction section. Total coal feed rate to the facility is 50,133 tons/day, based on a Western Kentucky coal with a moisure content of 9.2%. Capital investment was estimted to be $1897 million in first-quarter 1976 dollars, including $229 million working capital. The price of the fuel oil produced by the facility was calculated as a function of the debt-equity ratio, the annual earning rates on debt and equity, and the cost of coal. Using a debt-equity ratio of 70/30, an interest rate on debt of 9%, an after-tax earning rate on equity of 12%, and a coal feed cost of $20/ton, the price of the product oil was $22.60 per barrel. The calculated overall thermal efficiency of the facility was 59.6%.

55616 (ORNL—5211) **Evaluation of the Synthoil process. Volume III. Unit block flow diagrams for a 100,000 barrel/stream day facility.** Salmon, R.; Edwards, M.S.; Ulrich, W.C. (Oak Ridge National Lab., Tenn. (USA)). Jun 1977. Contract W-7405-ENG-26. 22p. (ORNL—5209(Vol.3)). Dep. NTIS, PC A03/MF A01.

This volume consists of individual block flowsheets for the various units of the Synthoil facility, showing the overall flows into and out of each unit. Material balances for the following units are incomplete because these are proprietary processes and the information was not provided by the respective vendors: Unit 24-Claus Sulfur Plant; Unit 25-Oxygen Plant; Unit 27-Sulfur Plant (Redox Type); and Unit 28-Sour Water Stripper and Ammonia Recovery Plant. The process information in this form was specifically requested by ERDA/FE for inclusion in the final report.

55617 (ORNL/TM—5034) **Engineering evaluations of coal conversion processes. Part I. Hydrocarbonization and Synthoil: information base, process selection, and preliminary evaluation of alternatives.** Salmon, R.; Holmes, J.M.; Joy, D.S. (Oak Ridge National Lab., Tenn. (USA)). Aug 1977. Contract W-7405-ENG-26. 176p. Dep. NTIS, PC A09/MF A01.

This report covers the first phase of a project sponsored by the ERDA Division of Coal Conversion and Utilization for the process design and evaluation of the hydrocarbonization and Synthoil processes. As part of this evaluation, a survey was made of the experimental data and other information available for the design of full-scale facilities for each process. An assessment was made to determine the adequacy of the data available for design purposes. Preliminary process design bases have been prepared for facilities with fuel oil outputs of 100,000 bbl/day in each case.

PYROLYSIS AND CRACKING

REFER ALSO TO CITATION(S) 55635

55618 (CONF-760885—, pp 40-58) **Properties of coal liquids produced by the Occidental flash pyrolysis process.** Che, S.C.; Dolbear, G.E.; Longanbach, J.R. (Occidental Research Corp., LaVerne, CA). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

A discussion is presented on the liquids prepared by flash pyrolysis of coal. The company has had a process to accomplish this under development for several years. Some background information on the process is given followed by a discussion of the tars prepared and a comparison of them with coal tars from two other pyrolysis approaches. Pyrolysis of coal is analogous to distillation of crude petroleum in that coal is separated into fractions.

SOLVENT EXTRACTION

REFER ALSO TO CITATION(S) 55599, 55610, 55633, 55712

55619 (CONF-760885—, pp 101-124) **Kinetics and mechanisms of solvent refining coal.** Farcasiu, M.; Mitchell, T.O.; Whitehurst, D.D. (Mobil Research and Development Corp., Princeton, NJ). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

A study of the SRC Process leads to the following conclusions: coals are rapidly converted to soluble form (bituminous coals require less than 3 min. at 800°F); coal particle integrity does not have to be destroyed to convert coal to soluble form; lowering the oxygen content of the coal will not necessarily lead to solubilization; oxygen and sulfur removals are kinetically parallel (approximately 40 percent of each is easily lost); high hydrogen consumption is not necessary to achieve solubilization; the aromatic content of coal goes up, not down, on being converted to SRC; the number of polycondensed aromatic rings goes up, not down on converting coal to SRC; the molecular weights of SRC components after the first few minutes of conversion are low (300 to 900 MW), and those of individual chemical species do not change appreciably on further conversion; benzene-insoluble materials are the predominant initial products and are converted in a parallel fashion to benzene-soluble (asphaltenes) and hexane-soluble (oils) products; and asphaltene components are major consumers of hydrogen.

55620 (CONF-760885—, pp 234-238) **Approaches to the analysis of solvent refined lignite.** Woolsey, N.F.; Baltisberger, R.J.; Klabunde, K.J.; Stenberg, V.I.; O'Reilly, E.J. (Univ. of North Dakota, Grand Forks). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

The structure of heavy, nonvolatile, soluble, coal-derived products has remained a difficult analytical area. Solvent-refined coals are a particularly important constituent of this class. An attempt is being made to obtain structural information about solvent-refined lignite (SRL) utilizing only readily measured analytical properties. Progress thus far using a computerized modeling approach will be summarized. A second area of some current interest concerns the acid/base properties of solvent-refined coals. An investigation has been made of the acidic and basic titers of solvent-refined lignite (SRL) both before and after ion exchange chromatographic separations of the THF-soluble fraction of SRL. These results are summarized briefly.

55621 (FE—496-129) **Solvent Refined Coal (SRC) process. Quarterly technical progress report, July—September 1976.** (Pittsburg and Midway Coal Mining Co., Merriam, Kans. (USA)). 1976. Contract EX-76-C-01-0496. 55p. Dep. NTIS, PC A04/MF A01.

A summary is presented of the progress of the Solvent Refined Coal (SRC) Project by The Pittsburg and Midway Coal Mining Co., for the Energy Research and Development Administration for the period July 1, 1976 to September 30, 1976. Activities include the operation of the Solvent Refined Coal Pilot Plant at Ft. Lewis, Washington and Process Development Laboratory at Merriam, Kansas. The Ft. Lewis SRC Pilot Plant continued the task of producing SRC for the 3,000 ton combustion test at Plant Mitchell, Albany, Georgia. Total production for the third quarter was 742.6 tons, bringing the total production for the year to 2244 tons. Since the production run started one year ago the Pilot Plant has produced 2644 tons of specification grade Solvent Refined Coal (SRC). During the past year the Pilot Plant has established an on stream factor of better than 60%. The mineral separation and solvent recovery areas (03 and 04) were the major source of plant problems. A pre-SRC II shutdown was initiated at the end of August and continued through the first part of September to extensively inspect all vessels and exchangers in the plant. By the end of the quarter modification for SRC II operations were proceeding on schedule with engineering and concrete and structural steel subcontracts 98% and 75% complete, respectively. The laboratory in Merriam continued work on the development of the SRC II Process completing ten runs in two special experimental series.

55622 (FE—496-134) **Solvent Refined Coal (SRC) process. Quarterly technical progress report, January—March 1977.** (Pittsburg and Midway Coal Mining Co., Merriam, Kans. (USA)). Jul 1977. Contract EX-76-C-01-0496. 112p. Dep. NTIS, PC A06/MF A01.

The progress of the Solvent Refined Coal (SRC) Project by The Pittsburg and Midway Coal Mining Co. for the Energy Research and Development Administration for the period January 1, 1977 to March 31, 1977 is summarized. Activities include the operation and modification of the Solvent Refined Coal Pilot Plant at Fort Lewis, Washington and process development work at the laboratory in Merriam, Kansas. The Fort Lewis SRC Pilot Plant was operated only 14 days during January prior to being shut down for SRC II modification. During the January operating period, the filtration test program begun in late 1976 was completed. Results of the program are presented. For the remainder of the quarter the pilot plant underwent extensive inspection, repairs, and modification in preparation for SRC II operation. In the SRC II process, formerly referred to as the slurry recycle mode of operation, a portion of

unfiltered coal solution will be recycled to the slurry preparation area. The longer residence time of the slurry, the somewhat higher reaction pressure, and the recycle of unfiltered coal solution yield a liquid fuel as the principal product. Process development work at the Merriam Laboratory has defined the operating parameters for SRC II operation using Kentucky No. 9 coal. A brief series of trials using the Amax coal in an SRC I mode of operation was also begun. A summary of the Merriam SRC II work is presented. The plant operated for 14 days during January to generate filtration data using B filter and the Johnson Screen. Reactor area conditions were held at a constant 3500 lb/hr coal feed and a 1.6 solvent-to-coal ratio to provide a consistent filter feed. Ninety-four tons of specification SRC were produced during this period. Analytical data from the January operating period are presented in tables. Only waste treatment units were in operation the entire quarter.

55623 (FE—496-T13) **Solvent refined coal (SRC) process. Development of a process for producing an ashless, low-sulfur fuel from coal. Volume III. Pilot plant development work. Part 3. Startup and operation of the SRC Pilot Plant. Research and development report No. 53. Interim report No. 22. Period covered: June 1974—April 1977.** (Pittsburg and Midway Coal Mining Co., Merriam, Kans. (USA)). Jun 1977. Contract EX-76-C-01-0496. 468p. Dep. NTIS, PC A20/MF A01.

This report covers the activity at the Ft. Lewis SRC Pilot Plant over about a three-year period from the time the various sections of the plant were accepted from the construction contractor in early 1974 until mid-April, 1977. Several different phases of operation were conducted during this period and each is discussed briefly below. The performance and problems encountered during this entire period of operation are reported in detail. Information is summarized in 158 tables and 99 figures.

55624 (FE—2010-01) **Characterization of coal liquids. Intermediate report for the period July—December 1975. Upgrading solvent refined coal process filter feed.** deRosset, A.J. (UOP, Inc., Des Plaines, Ill. (USA)). Feb 1976. Contract EX-76-C-01-2010. 31p. Dep. NTIS, PC A03/MF A01.

Filter feed from the Solvent Refined Coal (SRC) Process was furnished to UOP Inc., by Pittsburg and Midway Coal Co., DuPont Washington. This sample was the first of eight coal liquids to be characterized as to processability by conventional petroleum hydrorefining technology. Pretreatment was necessary to remove solids. Filtration at 105°C in the presence of 50% added toluene reduced ash from 4% to 0.01%, and benzene insolubles from 16.7% to 7.5%. The filtrate was catalytically hydrorefined at 1500 to 2800 psig, 390 to 410°C peak temperature, 0.3 to 1.0 LHSV. The filtrate was topped by vacuum distillation to give a 56.2% bottoms product; and by vacuum flash to give 56% and 41% bottoms products. These highly asphaltenic stocks were also hydrorefined under similar conditions. Hydrorefining in all cases reduced sulfur and benzene-insoluble content to negligible values. Conversion of heptane insolubles was first order, so that at a given feed rate of heptane insolubles, the percentage removed was the same. Similar kinetics held for nitrogen removal. A high severity run on vacuum flash bottoms containing 77% SRC converted over 50% of the SRC into the solvent boiling range, removed 94% of the heptane insolubles, and 88% of the nitrogen.

55625 (FE—2270-17) **Solvent refined coal (SRC) process operation of solvent refined coal pilot plant at Wilsonville, Alabama. Monthly technical progress report for June 1977.** Lewis, H.E.; Weber, W.H.; Usnick, G.B.; Hollenack, W.R.; Hooks, H.W. (Catalytic, Inc., Wilsonville, Ala. (USA)). Jul 1977. Contract EX-76-C-01-2270. 26p. Dep. NTIS, PC A03/MF A01.

The Wilsonville SRC pilot plant operated 469 hr, or was on-stream 65 percent of the time during June. The distillation section operated an additional 60 hr to condition process solvent. Bituminous coal from the Emery mine in Utah was processed for the first four days of the month and a material balance was completed. The plant was shut down for inspection, cleaning, and maintenance. On 10 June, the plant started processing Indiana V coal from the Old Ben mine and continued with this coal to the end of the month. Coal conversions with Indiana V coal were between 92 and 94 percent. The Funda filter was equipped with 80 x 80 mesh screens (0.0050" opening) and work continued with Celite 560 precoat material. After repairs were made to damaged screens and filter pans, a satisfactory SRC product was produced. The Sharples and the Dorr-Oliver centrifuges were operated in series, with the underflow from the Sharples going to the Funda filter. The filtration rates using the high-solids stream from the Sharples centrifuge were approximately twice the normal rate for this coal. An oil seal problem developed on the Sharples centrifuge before the Dorr-Oliver unit could be adjusted to produce specification SRC product. The T105 Fractionation Column is now in service on a continuous basis. Some final instrument adjustments are being made in order to produce the desired solvent cuts in the column.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 55551, 55589

55626 (FE—2233-2) **Catalytic activity of coal mineral matter. Interim report, April—September 1976.** Hamrin, C.E. Jr. (Kentucky Univ., Lexington (USA). Dept. of Chemical Engineering). Feb 1977. Contract EX-76-C-01-2233. 32p. Dep. NTIS, PC A03/MF A01.

Seven coals were selected and low temperature ash samples were prepared which gave yields of 6.93 percent for Bruceton Mine coal to 30.1 percent for Kentucky No. 11 coal. Characterization of the LTAs by x-ray diffraction, x-ray fluorescence, and thermogravimetric analysis was begun. X-ray diffraction of the raw coal samples was also carried out to show that little if any change occurred during low temperature ashing. With comparable weights of catalysts it was found that the activity for HDS of thiophene was montmorillonite < illite < FeS < kaoline < FeS_2. Preparation of compounds varying from FeS to FeS_2 was also carried out to establish the most active composition.

55627 **Petrochemical basic products from coal.** Kuehn, R.; Elstner, M. (Union Rhein Braunkohlenkraftstoff, Wesseling, Ger). *Erdoel Kohle, Erdgas, Petrochem. Brennst.-Chem.;* **30**: No. 3, 117-122(Mar 1977). (In German).

A study conducted by Union Rheinische Braunkohlen Kraftstoff AG to determine the prerequisites for producing petrochemical starting materials economically from coal by the Fischer-Tropsch process is discussed. A comprehensive literature research into the current Fischer-Tropsch technology led to an economic comparison of 12 processes. Based on the relation betwen costs and net profit, it is concluded that for the time being, the Fischer-Tropsch synthesis is not yet economically viable in Europe.

55628 **Effect of coke properties on blast furnace operation.** Hatano, M.; Fukuda, M. (Sumitomo Met Ind, Ltd, Amagasaki, Jpn). *Ironmaking Proc., Metall. Soc. AIME;* **35**: 2-20(1976).

A higher content of fine particles of charged coke allows them to accumulate at the boundary of raceway to hinder smooth gas flow to the furnace center and consequently, the gas flow toward the upper part of raceway is intensified. The internal pressure of raceway increases and the raceway is enlarged. Dynamic balance of gas and burden can be easily destroyed causing fluctuation of blast pressure. Lower strength charged coke accelerates the deterioration of coke size in the furnace, especially in the raceway. When the strength of coke is reduced, use of coarser particle coke and reduction of blast energy due to enlargement of tuyere diameter are effective. 4 refs.

PROPERTIES

REFER ALSO TO CITATION(S) 55552, 55561, 55571, 55572, 55595, 55597, 55598, 55599, 55610, 55613, 55619, 55620, 55628, 55666, 55701, 55716, 55727, 55737, 57191, 57192

55629 (AD-D—003508) **Coal catalyst.** Libby, H.F. (Department of the Air Force, Washington, D.C. (USA)). 23 Dec 1976. 10p. NTIS PC A02/MF A01.

A method for transforming coal into a petrochemical product by contacting powdered coal with a catalyst composed of coal ash is described.

55630 (CONF-760885—) **Preprints of the 1976 coal chemistry workshop.** Peters, H.M.; Ross, D.S. (eds.). (Stanford Research Inst., Menlo Park, Calif. (USA)). 15 Nov 1976. 244p. Dep. NTIS, PC A11/MF A01.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

Twenty papers were abstracted and indexed separately. Abstracts of 8 additional papers are included in the compilation.

55631 (CONF-760885—, pp 1-13) **Chemistry of coal surfaces.** Larsen, J.W.; Kennard, L.; Kuemmerle, E.W. (eds.). (Univ. of Tennessee, Knoxville). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

Coal is unique among organic natural products in that it is nearly insoluble in nearly everything. Most of its reactions take place at the interface between a fluid and the solid coal. Coal is a highly porous solid and the diffusion of reactants into and out of these pores may play an important role in coal reactions. The interactions of reagents with the coal surface is critical to coal chemistry. A systematic investigation of coal surfaces, their chemical characteristics, and the access of reagents to them has been undertaken.

55632 (CONF-760885—, pp 59-71) **Reactions of zinc chloride and coal.** Bodily, D.M. (Univ. of Utah, Salt Lake City). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

When $ZnCl_2$ is impregnated on coal and heated, the properties of both $ZnCl_2$ and coal are altered. The acid properties of $ZnCl_2$ are destroyed and there is no evidence of the formation of acidic complexes. The structure of the coal is altered. Hydroaromatic groups are destroyed and the surface area is drastically increased. These changes were studied in nitrogen atmospheres at low pressures. The conclusions cannot be directly related to hydrogenation conditions when hydrogen is present at high pressures. The results indicate that $ZnCl_2$ is capable of reacting with coal at relatively low temperatures, possibly forming a complex that is active for hydrogenation at higher temperatures.

55633 (CONF-760885—, pp 86) **Investigations on the nature of preasphaltenes derived from solvent refined coal conversion products.** Burk, E.H. Jr.; Kutta, H.W. (Atlantic Richfield Co., Harvey, IL). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

From a Solvent Refined Coal conversion product, the benzene-insoluble portion, designated as preasphaltenes, was isolated. It was found that the SRC-product from an Illinois No. 6 Coal contained approximately 60 preasphaltenes. These preasphaltenes exist as salt-like species and contribute greatly to the high viscosity of SRC Products. The preasphaltenes were separated into a basic nitrogen containing and an acidic hydrogen containing fraction by reaction with methyl iodide. The presence of a reaction product of basic nitrogen, a quarternary salt, was determined by anion exchange experiments. Both fractions were analyzed by spectroscopic and elemental analysis. About 80 percent of the basic nitrogen atoms are located in the preasphaltenes. The basic fraction in the SRC-product was found to be approximately 50 percent based on iodide labelling experiments. The average molecule in the basic fraction may contain more than one nitrogen atom. A graphical summarization of the physical and chemical properties of an Illinois No. 6 Coal conversion product is shown.

55634 (CONF-760885—, pp 135-143) **Thermochemistry and kinetics of coal conversion.** Stein, S.; Golden, D.; Benson, S.; Shaw, R. 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

Two tools are presented for estimating thermochemical quantities of chemical constituents and of reaction intermediates in coal conversion processes. The first method provides a simple means of estimating standard heats of formation, entropies, and heat capacities for substituted polycyclic aromatic compounds. This method is a direct extension of existing, highly developed, molecular group additive schemes for acyclic systems. The second tool enables estimation of bond strength and thermodynamic stabilities of highly conjugated free radicals, which are expected to be of primary importance in thermally induced coal reactions. Radical stabilization energy due to electron delocalization has been derived as E/kcal $mol^{-1} = 16.75 \ln[K(R)] - 20.19 \ln[K(RH)]$, where K(R) and K(RH) are the number of stable Kekule structures for the radical and for its parent molecule, respectively. Using existing estimation procedures, thermochemical quantities for all important hydrogenated naphthalenes, anthracenes, phenanthrenes, and pyrenes have been estimated and tabulated. These values enable equilibrium calculations to be made for different structural isomers, commonly assumed to be present in coal, and its derived liquids. Finally, initial application of these data and methods for analysis of free radical chemistry in coal reactions is presented.

55635 (CONF-760885—, pp 165-173) **Studies on the organic structure of coals.** Aczel, T.; Gorbaty, M.L.; Maa, P.S; Schlosberg, R.H. (Exxon Research and Engineering Co., Linden, NJ). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

All coal conversion processes currently being developed are based in chemistry which is at least fifty years old. These processes (liquefaction, gasification, and pyrolysis) are all run under severe conditions. A major incentive for study of the organic structural types in different coals is to identify technological limitations of coal processing imposed by the organic structure. Coal, as a heterogeneous rock, has an inorganic, a physical, and an organic structure. Even within the organic structure of coal, there is extensive heterogeneity and many structural types. We will concentrate in this presentation on discussing organic structural types for a particular coal maceral: vitrinite. Three quite different views of the structural types found in vitrinites from bituminous coals co-exist; the hydroaromatic, the aliphatic, and the molecule sieve models. The basis for the aliphatic model is briefly presented along with the method of testing this model. The results, which demonstrated the stability of adamantane type structures to liquefaction conversion conditions, argue in favor of a hydroaromatic structure. The problems created by the mineral matter in coal and by analytical techniques for coals are discussed briefly in terms of their impact on studies on the organic chemistry of coal.

55636 (CONF-760885—, pp 174-188) **Examination and comparison of structure: lignite, bituminous, and anthracite coal.** Winans, R.E.; Hayatsu, R.; Scott, R.G.; Moore, L.P.; Studier, M.H. (Argonne National Lab., IL). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

The structure of coal is thought to be a complex macromolecule containing aromatic hydrocarbons and heterocyclics extensively cross-linked. Characterization is important for several reasons. To understand coal gasification and liquefaction for fuel and chemical feed stock, the makeup and quantities of the major components should be known. Also, knowledge of the forms in which the nitrogen and sulfur atoms are found would be helpful in developing methods for their removal. Finally, identification of trace amounts of compounds which are potential environmental and health hazards is essential.

55637 (CONF-760885—, pp 189-201) **Oxidations of coal, coal fractions, and coal models.** Mayo, F.R.; Huntington, J.; Kirshen, N. 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

From results to date, it is concluded that bituminous coal contains enough easily separated fractions that oxidation and structure studies should be most concerned with the largest and most characteristic fractions. The 83% of Illinois No. 6 coal that is insoluble in pyridine represents the heart of the structure and liquefaction problems, uncomplicated by any already-soluble fractions. Separation of this fraction by density may be useful. For following molecular weight changes (bond cleavage) during oxidations, the pyridine-soluble, toluene-insoluble fraction appears to be most suitable. It is the major soluble fraction.

55638 (CONF-760885—, pp 202-218) **Analysis of the aromatic content of whole coals by high-power proton decoupled C-13 NMR.** VanderHart, D.L. (National Bureau of Standards, Washington, DC). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

It has been shown that the ^{13}C-^{1}H cross polarization (CP) method may be used to obtain ^{13}C spectra of whole coals, and that these spectra may be analyzed for the percentages of aromatic and nonaromatic carbon atoms. This presentation is intended to accomplish the following objectives: give a brief introduction to the experiment; discuss the ^{13}C lineshapes in coal and the criterion for the separation of aromatic and nonaromatic contributions; and present experimental results pertaining to the use of the CP technique in coals for analytical purposes.

55639 (CONF-760885—, pp 220-228) **^{13}C NMR studies of solid coal samples.** Bartuska, V.J. (Colorado State Univ., Fort Collins); Maciel, G.E.; Schaefer, J.; Stejskal, E.O. 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

Because of excessive line broadening in solids due to dipole-dipole interactions and chemical shift anisotropies, and because of long spin-lattice relaxation times, standard Fourier transform techniques do not yield structurally informative ^{13}C nmr data. However, the techniques of dipolar decoupling, especially using the cross polarization approach, and magic-angle spinning show great promise for making it possible to obtain ^{13}C nmr spectra routinely on solid samples. The application of these techniques to solid coal samples is discussed. It is shown that, without magic angle spinning, spectra obtained by dipolar decoupling display manifestations of chemical shift anisotropy which render ambiguous attempts to distinguish the resonances of aromatic carbons. However, with magic-angle spinning, the distinction can be made.

55640 (CONF-760885—, pp 229-232) **Application of novel NMR techniques to coal structure.** Pines, A.; Wemmer, D.E. (Univ. of California, Berkeley). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

The technique of proton-enhanced carbon-13 nmr promises to be a useful tool for the study of composition and structure of whole

coals. In particular, four functional types of carbons can be resolved and recognized in studies on model compounds and a series of coals: polycondensed aromatic, simple aromatic, oxygen bonded aliphatic, and simple aliphatic. This is discussed briefly and examples are presented.

55641 (CONF-760885—, pp 249-253) **Characterization of coal syncrudes at BERC.** Thompson, C.J.; Dooley, J.E. (Bartlesville Energy Research Center, OK). 15 Nov 1976.

From Coal chemistry workshop; Menlo Park, California, United States of America (USA) (26 Aug 1976).

In Preprints of the 1976 coal chemistry workshop.

Using techniques similar to those developed in petroleum studies, four coal syncrudes have been systematically separated and characterized. The combination of distillation, adsorption chromatography, GPC, and mass spectrometry provides a better characterization and interpretation than is possible by any single technique. Such characterization data greatly expand our knowledge of these materials and should be of interest and value to a refiner or processor in determining proper processing conditions to produce desired final products and to calculate the yields that can be obtained from a given material.

55642 (FE—2316-2) **Study of the mineral matter distribution in pulverized fuel coals with respect to slag deposit formation in boiler furnaces: Phase 1. Interim report, July—September 1976.** Austin, L.G.; Essenhigh, R.H.; Strickler, D.; Ohmine, S.; Morris, B. (Pennsylvania State Univ., University Park (USA). Dept. of Material Sciences). Dec 1976. Contract EX-76-S-01-2316. 46p. Dep. NTIS, PC A03/MF A01.

Analytical information dealing with coals that have high slagging problems has been obtained from the Pennsylvania Electric Company. Additional samples of coal which gave slagging problems will be sent to Penn State for analysis. Examination of pulverized coal from the Keystone plant by the scanning electron microscope has begun. Elements found in significant quantities were: Si, Al, K, Ca, S, Fe. These elements occurred singly or in association as follows: Si, AlSi, AlSiK, Ca, CaS, and FeS. The plane-flame furnace being used to conduct slag deposition experiments is being modified to increase the temperatures. The wetting and contact angle experiments have shown that a high iron content in the ash sample gives a lower contact angle. A new electric tube furnace has been constructed in which to perform the experiments in order to improve the reproducibility of the results. Tests in this new furnace are currently underway.

55643 (FE—2537-2) **Characterization of coal-derived liquids and other fossil fuel related materials employing mass spectroscopy. Quarterly report, December 30, 1976—March 29, 1977.** Scheppele, S.E. (Oklahoma State Univ., Stillwater (USA). Dept. of Chemistry). 13 Apr 1977. Contract EX-76-S-01-2537. 31p. Dep. NTIS, PC A03/MF A01.

A two-part report is being prepared that assesses the current state-of-the-art in mass spectral analysis of alternate fossil fuels and the needs of technical personnel for characterization data. Competitive bids were obtained on the specifications developed for the data acquisition system to be acquired for the CEC 21-110B double focusing mass spectrometer. Considerable progress has been made on developing field desorption capability in the laboratory. In this regard, satisfactory operation was demonstrated for the field-desorption emitter probe, the modified field-ionization power supply, the oxidation-reduction cell, and the FD emitter activation cell and its associated power supplies. Preliminary experiments were conducted using the technique of micromolecular probe distillation in combination with field-ionization mass spectrometry to obtain quantitative distributions for several test blends and for an acid fraction obtained from separation of the asphaltenes from a COED coal liquid. Based upon the Kendrick mass scale, computer programs are being developed for organizing high-resolution mass spectral data into homologous ion series grouped according to the hydrocarbon Z number and for assigning most probable molecular compositions to each of the measured masses.

55644 (NP—22126) **Agglomerated brown coal fine coke as a sintering fuel.** Dwiwanto, S.A. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Bergbau und Huettenwesen). 13 Feb 1976. 171p. (In German). Dep. NTIS (US Sales Only), PC A08/MF A01.

Thesis.

Carbonized lignite pellets, carbonized lignite, anthracite, lean coal, and petroleum coke were investigated within the framework of this study for their usability as space fuels. The object of the investigation was to compare the mechanical, physical, chemical, and kinetic properties of these fuels with those of the usual expensive sintering fuel pit coal coke, in order to replace the latter fuel by these. For this purpose, the finest carbonized lignite, as initial material were converted into pellets of optimum grain size by means of various added substances and by considering the known binding mechanism. By preparing the small pellets, important properties of these fuels could be changed in so many ways that a favorable sintering coke could be obtained. The tests showed that the added substances could improve the porosity, reactivity and ignition temperature of the fuels. A favorable combustion process within the sinter layer could thus be guaranteed so that sinter of the same goods quality such as with pit coal coke could be produced. On the whole, the test results appear to show that a replacement of pit coal coke by the agglomerated carbonized lignite as sintering fuel is advantageous so that one can expect the carbonized lignite pellets to find use in metallurgical plants. Finally, a formula to calculate the sintering efficiency could be constructed.

55645 **Inorganic sulfur in coal.** Gluskoter, H.J. (Ill State Geol Surv, Urbana). *Energy Sources;* 3: No. 2, 125-131(1977).

Organically combined sulfur and inorganic sulfides comprise nearly all the sulfur found in coals. Pyrite and marcasite are the dominant iron sulfides in coals. The wide range of sizes and forms they exhibit results from the different geochemical environments that affected their formation in the coals during their long history. Other sulfides that have been reported are sphalerite, galena, chalcopyrite, and arsenopyrite. Sulfate materials are much less common in fresh coal samples, but a variety of ferrous and ferric sulfates form when the ferrous sulfides are oxidized. Removal of inorganic sulfur from coal by standard specific gravity techniques is, at best, incomplete. 12 refs.

55646 **Reflecting power of vitrinites of Polish coals and its correlation with indices of coal class.** Chrusciel, Z. *Przegl. Gorn.;* 32: No. 12, 547-551(Dec 1976). (In Polish).

Results of investigations in the Upper and Lower Silesian Coalfields are presented. The correlation of the reflecting power of vitrinites with other parameters determining the degree of metamorphism of coal substance is discussed together with the effect of coal oxidation on the reflecting power of vitrinites. In the case of coals naturally oxidized no correlation between the index of reflecting power and other properties of coal are found. 6 refs.

55647 **Reinhardt Thiessen coal thin-section slide collection of the U.S. Geological Survey: catalog and notes.** Schopf, J.M.; Oftedahl, O.G. Washington, DC; Geological Survey (1976). 62p.

The Reinhardt Thiessen Coal Thin-Section Slide Collection of more than 19,000 slides from 682 different localities includes abundant examples of coal from most American coal fields and from other parts of the world. The collection includes examples used in early studies of coal, on which the first quantitative system of coal petrography was based, and is of historic interest in its relation to studies of the origin of coal and coal classification. All available sections studied at the U.S. Bureau of Mines and at the U.S Geological Survey, using Thiessen's system of coal petrography, are included as well as sections of various oil shales and peat. The catalog is organized according to coal basins and geographic areas, as is the collection, and is intended to facilitate reference. 14 refs.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 55582, 55617, 55642, 55684

55648 (PB—265229) **Permeability of fly ash and fly ash stabilized soils. Final report on highway research project no. 47.** Parker, D.G.; Thornton, S.I. (Arkansas Univ., Fayetteville (USA). Dept. of Civil Engineering). Dec 1976. 104p. NTIS PC A06/MF A01.

Sponsored in part by Arkansas State Highway Dept., Little Rock.

Fly ash, a pozzolanic by-product of coal burning power plants, is an abundant potential source of highway and embankment construction material. Some fly ashes are suitable for use as a supplement or replacement for lime and portland cement in soil stabilization applications. The following conclusions are based on the results of a study using a fly ash produced from Wyoming low sulfur coal and two Arkansas soils. (1) Addition of fly ash to clay or sand reduces the permeability. The fly ash was more effective in reducing the permeability of sand (permeability reduced three orders of magnitude at 50% fly ash) than in clay (reduced by a factor of 4 at 50% fly ash). (2) Permeability does not vary greatly with time. (3) Increased compactive effort increases density and reduces permeability in soils. However, reduction in permeability due to increased compactive effort are usually small. (4) The permeability of fly ash, placed in a slurry, varies between 0.0001 cm/sec and 0.000001 cm/sec depending on the amount of water in the slurry. (5) Fly ash placed dry, then saturated, developed shrinkage cracks which created secondary permeability.

55649 (PB—265374) **Characterization of ash from coal-fired power plants. Milestone report May 75-Mar 76.** Ray, S.S.; Parker, F.G. (Tennessee Valley Authority, Chattanooga (USA)). Jan 1977. 142p. (PRS—18). NTIS PC A07/MF A01.

Report on Federal Interagency Energy-Environment Research and Development Program Report.

A summary is presented of existing data on the chemical and physical characteristics of ashes produced by the burning of coal in steam-electric generating plants. It summarizes several recent coal or ash characterization studies, emphasizing the elemental chemical composition, particularly trace inorganic constituents. The studies agree generally on partitioning of trace elements between bottom ash, fly ash, and flue gas. The report examines coal and ash analysis methods, to aid in evaluating and comparing results from studies that do not use identical analytical methods. The need for a standard set of analytical procedures for coal and ash is evident. Also summarized are the physical and chemical characteristics of sulfur dioxide scrubbing sludges, which are becoming a significant portion of total power plant residues.

55650 (UCRL—79146) **Silica vaporization and condensation: a potential source of fouling in coal combustion.** Taylor, R.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Mar 1977. Contract W-7405-ENG-48. 7p. (CONF-770411—2). Dep. NTIS, PC A02/MF A01.

From Conference on high temperature sciences related to open-cycle coal fired MHD systems; Argonne, Illinois, United States of America (USA) (4 Apr 1977).

The transport of silica from coal ash to the gas phase and then to the surface of heat exchangers or turbines can be a serious problem, particularly at the high temperatures projected for improved coal utilization. The problem is most severe in combustion at low oxygen pressures or high steam pressures. The amount of silica that can be transported in the gas phase has been shown to depend upon the square of the steam pressure. Thus, with respect to this vapor-transport mechanism, coals that contain little hydrogen (high-rank coals) should demonstrate the lowest fouling tendency. The actual thickness of the silica layer on high-temperature equipment depends upon the fraction of the condensed silica which sticks. In this report, the estimate of the maximum average thickness of the silica layer is based on the assumption that all of the silica sticks and that the deposition is of uniform thickness. Neither of these assumptions is correct, but they balance one another. Only a small fraction of the total amount of silica which condenses will stick, and it will probably tend to stick at only a few locations.

55651 Dustfree removal of electrically filtered flyash experiences with screening. Mueller, E. (Chem Fabr Kalk, Koeln-Kalk, Ger). *Energie;* **29**: No. 2, 36-38(Feb 1977). (In German).

The methods of removal of ash from coal-fired boilers are reviewed. The possiblities of elimination of fine dust from brown coal are outlined. Particular attention was paid to screening of granular coal from slurries.

55652 Selective agglomeration in the treatment of fine coal refuse. Nicol, S.K.; Swanson, A.R. (BHP Cent Res Lab, Shortland, Newcastle, Aust). *Aust. Min.;* 69: No. 2, 42-43(Feb 1977).

Pilot scale results are promising. The colour and quality of the tailings were such that these could be rapidly dewatered in dams and the clarity of the liquid produced would be such that it would not constitute any water pollution hazard. The successful use of a low cost sieve bend to achieve product separation and dewatering means that the capital costs involved would probably make the process viable for the treatment of the relatively small dams associated with scalping plants as well as the discarded fines from large scale desliming operations. 2 refs.

55653 Feasibility of using electrochemical coagulation to purify mine water. Bochkarev, G.R.; Fedosova, V.Y.; Sryvtseva, B.P.; Ryashentseva, E.S. (Inst of Min, Acad of Sci of the USSR, Novosibirsk). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 3, 328-332(May-Jun 1976).

Electrochemical coagulation removes 100% of the suspended matter as compared with 24% in existing purification facilities, and that the hardness, salinity, and organic impurity content are markedly reduced. Petroleum products are completely removed. The following scheme is proposed for the removal of suspended matter from mine waters in collieries: electrochemical coagulation $yields$ settling for 30-60 min $yields$ filtration (granular filter of sulfonated coal). The cleaned water may be recycled for the industrial needs of the colliery. The cost of 1 cubic meter of purified water (without the capital investment) is 0.42 kopecks. The use of electrochemical coagulations obviates the necessity for reagents, the purification scheme is simpler to operate, and contamination of the purified water by chemical reagents is eliminated. 9 refs.

55654 Removal of contaminants from industrial gaseous effluents. Hughes, R. (Univ. of Salford, Eng.). *Chem. Eng. (London);* No. 315, 754-756(1976).

An attempt has been made to review the methods available for removal of three noxious air pollutants, namely sulfur dioxide, oxides of nitrogen, and hydrogen sulfide, from plant flue and tail gases. It would appear that H_2S removal is not a serious problem since a number of very efficient methods are available which are capable of virtually 100 percent removal of this impurity. With oxides of nitrogen produced from combustion sources there is a problem but this can be minimized by the choice of appropriate combustion conditions. Methods are also available for removal of NO/sub x/ from nitric acid plant tail gases but the resultant gas may still have concentrations of NO/sub x/ which may be locally unacceptable in the future. Sulfur dioxide abatement is possible, the most efficient method being flue gas desulfurization, but the costs appear to be too great under present circumstances to justify the universal adoption of this method for power generating plants and it would seem that the high stack policy of dispersing SO_2 will prevail for the majority of stations for a number of years yet.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 55560, 55566, 55584, 55605, 55606, 55607, 55649, 55671, 55939, 57378

55655 (NP—22076) **Coal development information packet. Supplement 1.** Christiansen, B. (Montana Energy Advisory Council, Helena (USA)). Jul 1975. 79p. Energy Advisory Council, Helena, MT.

This supplement to the Coal Development Information Packet prepared and distributed by the Montana Energy Advisory Council in December 1974 is intended to provide a brief summary of "socio-economic" information pertinent to existing and potential energy development activities in Montana. The benefits of industrialization of Eastern Montana's coal reserves have been much touted. Increased revenues to state, county and local governments, more jobs at high wages and stimulation of "sagging" economies have been presented as immediate and lasting benefits. However, attention to the known and possible costs of such development has been limited to the efforts of a few prestigious research organizations, state government, a few federal agencies and some small citizen's organizations. Some of the costs are quantifiable in a monetary sense; many others are not and, as a result, often are not documented. It is to these latter costs that the bulk of this supplement is addressed. To date, little beyond conjecture is available to define the date, scope and type of industrial development to be expected in Montana's coal area. Until state government defines the development that is acceptable to it, and until some clarification of the degree to which the federal government will allow state self-determination is made, those groups who must deal with development will have to rely heavily upon educated guesses. Assuming large-scale development is to occur, state, county and local governments must not only determine what demands such growth will place upon their services, but must also devise plans to meet those demands. This problem is affecting all levels of government in the coal development area in Montana. It is not sufficient to respond simply to immediate demand—these government structures must comprehend the ultimate service needs in order to generate appropriate, efficient and effective programs to meet both present and ultimate demands.

55656 (ORAU/IEA(O)—77-15) **Present and future production of CO_2 from fossil fuels: a global appraisal.** Rotty, R.M. (Institute for Energy Analysis, Oak Ridge, Tenn. (USA)). Jun 1977. Contract EY-76-C-05-0033. 22p. Dep. NTIS, PC A02/MF A01.

Levels of atmospheric carbon dioxide is a question of worldwide proportions. Unilateral action by any one nation in planning alternatives to fossil-fuel use will most likely be ineffective in controlling carbon dioxide. Energy growth in the past has been largely based on fossil fuels and, consequently, the annual carbon dioxide production has increased steadily at 4.3%. In 1976 the global carbon dioxide production contained more than 5 billion metric tons of carbon. Of this, 27% was a result of activity in the United States, but by 2025 the total will have grown more than fivefold with the developing countries and communist Asia producing over half the global total. The challenge to the United States is to develop energy supply systems not based on fossil fuels which can and will be used by developing nations.

55657 Study of microseismic activity associated with a longwall coal mining operation using a near-surface array. Hardy, H.R. Jr.; Mowrey, G.L. (Pa State Univ, University Park). *Eng. Geol. (Amsterdam);* 10: No. 2-4, 263-281(Dec 1976).

The mine under study is located some 600 ft. below surface. Seismic events associated with controlled roof failure, and with stress development in both the roof and adjacent pillars were monitored by a seven-station near-surface array. The studies were carried out over a 6-month period during which the longwall face moved horizontally some 800 ft. below the area defined by the seismic array. Brief details are presented of the mobile monitoring system and the analysis techniques employed. Typical results obtained during the study are discussed along with suggestions for improving future studies of this type. 7 refs.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 55678

55658 (NP—22116) **Report on coal. Status report of the Ad Hoc Committee on Energy Resources and Technology of the Atomic Industrial Forum, March 1975.** Gambs, G.C. (Ford, Bacon and Davis, Inc., New York (USA)). [nd]. vp. Bacon and Davis, Inc., New York, NY.

The following sections are included in this report: Total Known Resources and Reserves of Coal and Lignite in the United States of America; Reserve Base of Coal Presently Available; Reserves of Coal Available at Given Environmental Restraints and Effect on Availability of Reserves with Relaxation of the Restraints; State of the Art of Coal Production, Coal Prices, Synthetic Fuels from Coal, Progress and Forecasts; Research and Development Program Goals, Current Trends and Optimization; Level of Development Required for Each Project as Projected in the Nation's Energy Future; Maximum Accelerated Approach; Support of Research and Development—Nation's Energy Future; Supply of Coal Projected for 1975 to 2000; Capital and Other Requirements for Commercialization; Uses and Benefits of the Resource of Technology; President Ford's Energy Program in His State of the Union Message to Congress of January 15, 1975; Conversion of Electric Utility Plants and Industrial Plants from Oil and Natural Gas to Coal; and National Petroleum and Natural Gas Conservation and Coal Substitution Act of 1975—Senate Bill S. 1777.

55659 (NP—22279) **Guidebook to coal geology of northwest New Mexico. Circular 154.** Beaumont, E.C.; Shomaker, J.W.; Stone, W.J. (comps.). (New Mexico Bureau of Mines and Mineral Resources, Socorro (USA)). 1976. 58p. Mexico Bureau of Mines and Mineral Resources, Socorro, $6.00.

This guidebook contains geologic road logs for a three-day field trip on the coal resources of northwestern New Mexico. The first day focuses on the Madrid coal field, northeast of Albuquerque. The second and third days are devoted to the coals of the San Juan Basin. The guidebook also contains three technical papers covering the Cretaceous stratigraphy of the Madrid coal field, the palynology of the Crevasse Canyon and Menefee Formations, and the availability of ground water for coal development in the San Juan Basin.

55660 (PB—265182) **Data accumulation on selected coal measures in the Warrior Basin of Alabama including search of unpublished reports and surface field mapping. Open file report.** (Geological Survey, University, Ala. (USA)). 16 Mar 1976. 76p. NTIS PC A05/MF A01.

In attempting to predict coal cleat orientation in the subsurface for effective methane degasification of the coalbeds in the Warrior coal field of Alabama, approximately 150 rock joint orientations and 45 coal cleat orientations were measured in each of 37 7-1/2-minute quadrangles in Tuscaloosa, Walker, Jefferson, Fayette, Winston, Blount, and Bibb Counties. Data from these surface locations and coal cleat data from eight underground mines were corrected for magnetic declination and titled beds rotated to the horizontal where necessary and plotted on rose diagrams for comparative analysis. Data collected on each joint and cleat consisted of attitude, quality, type, spacing, persistence, lithology, bedding thickness, surface texture, and filling.

55661 (USGS-OFR—76-869) **Preliminary report on 1975 drilling of lignites in western North Dakota: Adams, Bowman, Dunn, Hettinger, McLean, Mercer, Oliver, Slope, and Williams Counties.** (Geological Survey, Washington, D.C. (USA); North Dakota Geological Survey, Grand Forks (USA)). 1976. 146p. TIC.

A drilling program was conducted in western North Dakota by the North Dakota Geological Survey under a grant from the U.S. Geological Survey. The drilling was done as part of the U.S. Geological Survey's program to evaluate and classify mineral lands in the public domain. The purpose of the program was to gather data on the thickness, quality, extent, and recoverability of lignite beds and the lithologic characteristics of the coal-bearing unit, the Fort Union Formation (Paleocene), in western North Dakota. Geophysical logs, lists of lignite beds, and locations of the test holes are included. The descriptive terms, sand, silt, and clay, reported by the geologist, were modified to sandstone, siltstone, and claystone to conform to the U.S. Geological Survey's policy of using lithologic (rock-unit) terms for bedrock formations. A core sample was taken from one test hole and is currently being analyzed for proximate analyses, Btu/lb values, form of sulfur present, and trace elements. Chemical analyses are also being run on the ash. Samples were described as collected and no depth adjustments based on logs were made. The lists of lignite beds were made from the density logs.

55662 **World coal resources.** Silora, W.; Rago, W. *Przegl. Gorn.;* **32**: No. 12, 517-523(Dec 1976). (In Polish).

In general, there is no systematic information on the integrated assessment of world coal resources. An attempt is made at presenting this subject in the the light of recent literature. 3 refs.

55663 **Basaltic intrusion and its influence on coal in Seam 507 at Sosnica Colliery.** Duzniak, S.; Gabzdyl, W.; Kapuscinski, T. *Przegl. Gorn.;* **32**: No. 12, 524-528(Dec 1976). (In Polish).

Observations and tests show that the range of thermal metamorphism and its influence on the coalification degree of seams is considerably wider than it was admitted until now for the coal measures of the Upper Silesian Coalfield. Chemical analysis of basalt and coal in the mine is given. 12 refs.

55664 **Geography of energy production in France. IV. Natural regions: the inland north and Lorraine.** Oizon, R. *Rev. Energ.;* **27**: No. 289, 583-589(Dec 1976). (In French).

The coal basin of the Nord and Pas-de-Calais provinces as well as the industrial region of Lorraine , which is essentially concerned with coal and in an accessory manner with steel-works are discussed. In 1960, the Nord-Pas-de-Calais and the Lorraine had been for a long time and were still in the first two positions among the economic regions for the production of energy--essentially based on coal and its immediate derivatives (agglomerates, coke) and in a second stage on standard thermic electricity. Together, these two regions were responsible for more than a third of France's final energy production. Their portion today is less than 15%. The present evolution can only slow down this decline in the local economic context, but the overall situation appears to be permanently unfavorable.

55665 **Power industry of Siberia in the tenth five-year plan period.** Popyrin, L.S.; Savel'ev, V.A.; Slavin, G.B. (Sib Energet Inst, Acad of Sci of the USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* 3-8(Nov 1976). (In Russian).

All the increase of oil and gas output and 90% of the increase of coal output in the USSR in the 1976-1980 FYP period is to take place in Siberia. Siberia comprises over 60% of potential coal resources of the USSR, about 40% of gas, 33% of hydraulic power, and huge oil fields. In the 10th FYP period, three major energy complexes will be developed in Siberia: the West Siberian oil and gas complex, the Kansk-Achinsk fuel and energy complex, and the Angara-Yenisey hydraulic energy complex. In the West-Siberian complex, the output of oil will reach 300-310 Mt and of gas 125-135 Gm^3, i.e. 50 and 30-35% respectively of the total Soviet output. The Kansk-Achinsk complex is based on a unique brown coal basin with reserves amounting to 450 Gt, including 100 Gt of proven reserves. The basin can provide the output of 1Gt of coal per annum at the specific costs below R.3/tec. The first stage of development of the basin envisages the construction of 10-12 power plants with the total capacity of 60-75 MkW. In 1975 the total installed capacity of power plants of the unified Siberian system amounted to 26.5 MkW.

55666 **Semi-coking coal resources of Raniganj coalfield.** Chatterjee, C.N.; Ghose, S. (Cent Fuel Res Inst, Dhanbad, India). *J. Mines, Met. Fuels;* **24**: No. 10, 317-326, 337(Oct 1976).

Metallurgical cokes for most steel plants in India are manufactured from ternary blends of prime, medium, and semicoking coals. In order to conserve the limited resources of higher-grade coking coals, the semicoking coals are designed to become important constituents in the coking blends. The Raniganj coalfield is the major source of such coals in India. This paper deals with different types of semi-coking coals available from various seams in the area, and examines their quality and properties. 12 refs.

55667 **Prereduction of iron ore.** Ghosh, P.C. (Cent Fuel Res Inst, Dhanbad, India). *J. Mines, Met. Fuels;* **24**: No. 9, 290-292(Sep 1976).

A brief review is presented of major processes for prereduction of iron ore, as well as existing and planned facilities throughout the world. The possibility of erecting such an iron ore prereduction plant in India is examined in the light of the country's large iron-ore deposits and limited reserves of coking coal which, however, has a high ash content. India has reserves of over 22 billion tonnes of high-grade iron ores and about 2 billion tonnes of coking coal. Assuming that consumption of 0.75 tonne of coal is required per 1 tonne of iron ore for the production of pig iron, India's coal reserves would be big enough to support a 50-million-tonne/yr steel industry for the next 50 years. 17 refs.

MINING

REFER ALSO TO CITATION(S) 55582, 55588, 55653, 55655, 55721, 55736, 55737, 55738, 55740, 55779

55668 **Experimental study on roadway swelling in coal mines--1. Effect of roadway depth on swelling.** Hakao, Z.; Yoon, J. *Nippon Kogyo Kaishi;* **92**: No. 1064, 663-668(Oct 1976). (In Japanese).

Scale model experimental studies using equivalent materials, and effects on roadway depth and advance of upper coal face to the swelling are discussed. Vertical and horizontal displacements of floor in accordance with the advance of upper coal face are measured, and results on the characteristics of floor displacements are reported. 6 refs.

55669 (AED-CONF—76-417-001) **Surface mining of brown coal, its environmental influence and future prospects: illustrated by the example of the Rhenish brown coal mining industry.** Gaertner, E. (Rheinische Braunkohlenwerke A.G., Koeln (Germany, F.R.)). Sep 1976. 27p. (In German). (CONF-7609137—1). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Annual meeting of process engineers; Duesseldorf, German, Federal Republic of (F.R. Germany) (29 Sep 1976).

The importance of Rhenish brown coal as a domestic energy carrier is pointed out, the development of the Rhenish brown coal mining industry since 1950 is dealt with, and the marked increase in haulage due to rationalization and technical progress is stressed. The latest state of mining equipment (bucket wheel excavators, conveyor roads, spreaders) is illustrated by design data. The problem of recultivation is discussed. Further chapters deal with the systematic planning of the Hambach open cast mine and with research and development activities in the field of brown coal utilization.

55670 Feed system of a coal getting combine. Balinov, I.M.; Samsonov, G.N.; Balykov, V.M.; Paramonov, V.I.; Demyashkin, N.M. US Patent 4,025,120. 24 May 1977. Filed date 7 Jun 1976. 12p.

The feed system of a coal getting combine, which works with a face conveyor, comprises: a traction device located on the combine and having a cylinder shaped sprocket on the side surface of which a circular spherical-shaped recess is provided, slots being made on both inner sides of the spherical recess, said slots having an involute-spherical surface. Arranged lengthwise of the conveyor is a longitudinally traversable guide bar secured at the ends of the conveyor and composed of a number of separate tubular sections articulated together and provided with open-end holes arranged square with the longitudinal axis of said holes. Engagement elements are mounted in the holes of the tubular sections allow motion pivotally around their own axis and traversably, within certain limits, lengthwise of the hole axis, said elements being adapted to interconnect said sections to the traction device and being shaped as fingers with hemispherical ends, the fingers are so positioned that their ends project beyond the holes on both sides of the sections. The circular spherical-shaped recess in the sprocket follows the tubular shape of the sections, and the sprocket itself is adapted to straddle the sections in such a manner that the finger ends should engage the sprocket slot, thus effecting the involute-spherical mangle-type gearing, whereby the fingers can be turned. 11 claims, 13 figures.

55671 (IS-ICP—44) **Strip-mining and small mammals in southern Iowa.** Voight, J.R.; Glenn-Lewin, D.C. (Iowa State Univ. of Science and Technology, Ames (USA). Energy and Mineral Resources Research Inst.). Apr 1977. 19p. Dep. NTIS, PC A02/MF A01.

Small mammal presence, diversity and reproduction were compared from August 1975 to June 1976 on abandoned coal strip-mine spoils and unmined land in southern Iowa. More species were snap-trapped on the unmined area, while the relative dominance of Peromyscus spp. on mined land was increased. Peromyscus populations on mined land exhibited a shorter breeding season than on unmined land. Other population parameters did not show clear differences between the areas.

55672 (PB—264997) **Evaluation of wet-head drilling techniques. Open file report.** Purvis, D.G.; Hagenbuch, F.H. (FMC Corp., Santa Clara, Calif. (USA)). May 1976. Contract J0155131. 69p. NTIS PC A04/MF A01.

Results are reported on the wet-head drilling program, with regard to data collection and testing and evaluation of rotary and pneumatic drills. Performance of a noise-abated stoper, though extremely limited in scope, is also presented. Comparisons are made in roof of 40 to 60 Shore hardness. Data include drilling rates, bit costs, dust suppression/waste removal, safety, functional limitations, and similar information. It is concluded that wet drilling is faster, quieter, and easier on the operator than stoper drilling, although on the average wet drilling requires more bits than stoper drilling.

55673 (PB—265073) **Fabricate and evaluate protective canopies for 3-foot coal seams. Final report, 1975—1976.** Hermanson, W. (Bendix Corp., Denver, Colo. (USA). Energy, Environment, and Technolgy Office). Jun 1976. Contract H0357090. 157p. NTIS PC A08/MF A01.

Canopies were designed, fabricated, installed, and demonstrated for mining machinery in 3-foot coal seams. The machine operators' comments were adverse in each case. Restriction of visibility and body constriction into unaccustomed and tiring attitude were major objections, causing increased hazards and fatigue. Recommendations are made that roll bar protection be furnished in place of canopies for 3-foot seams to provide partial protection by deflecting and supporting roof falls but not covering the head of the operator. In this way, the effect on visibility would be minimized and fatigue from body restriction would not be increased.

55674 Method and apparatus for strip mining. Watts, J.P. US Patent 4,025,119. 24 May 1977. Filed date 1 Dec 1975. 8p.

A method of strip mining in which a plurality of vertical shafts of square cross section are formed closely adjacent to one another with each shaft extending through overburden and a layer of valuable material such as coal is described. As spoil is removed in forming one shaft it is conveyed to a previously formed shaft and deposited therein. The apparatus includes a casing of square cross section, a cylindrical auger casing within the square casing, an auger rotatable in the auger casing and a square cutter at the lower end of the square casing. The latter is slidably mounted on a vertical track and is power driven vertically to force the cutter into the earth formation being worked. The auger is rotated under power to cut into the earth formation and remove spoil and coal therefrom. The upper end portions of both casings are formed with two sets of aligned discharge ports. A movable closure is provided for each set and a rake for each set. A conveyer for spoil has one end connected to the outer port of one set while a conveyer for coal has one end connected to the outer port of the other set. When one set is closed, the rake associated therewith is in an inoperative position. When a set of ports is open, the rake associated therewith extends into the uppermost convolution of the auger. 13 claims, 6 figures.

55675 Spill-plate apparatus for a mining machine. Lanfermann, W.; Renzing, O. (to Gebr. Eickhoff, Maschinenfabrik und Eisengieserei mbH). US Patent 4,025,118. 24 May 1977. Priority date 29 Nov 1974, German, Federal Republic of (F.R. Germany). 8p.

A spill-plate housing extends along one side of the course of travel by a mining machine. A flexible cutter cable and water conduit are carried from the mining machine by a carrier arm for extending into the spill-plate housing by projecting through a longitudinal slot formed in a faceplate of the housing. Upper and lower resilient apron strips are secured to the faceplate so that their longitudinal edges abut along the longitudinal center of the slot. Vertical support pipes are secured to the faceplate by upper and lower members to form an internal housing space adapted to accommodate the cable and conduit while coupled to the mining machine. Bias blocking arms are pivotally supported by the faceplate within the housing to prevent unintentional emergence of the cable from the slot in the housing. Pipe-engaging surfaces on clamp plates arranged at opposed sides of the vertical support pipes are used to carry a door for vertical movement to expose the interior of the housing space. 14 claims, 5 figures.

55676 Coal planer. Bahre, K.; Nowak, H.D. (to Klockner-Werke AG). US Patent 4,025,117. 24 May 1977. Priority date 4 Apr 1975, German, Federal Republic of (F.R. Germany). 6p.

A coal planer for use in an underground mine gallery comprises a central unit, a pair of loading heads arranged spaced from and to opposite sides of the central unit and a pair of intermediate units, respectively, located between the central unit and the loading heads and linked to the latter and the central unit. Each of the intermediate units is provided with a plurality of planning knives arranged vertically spaced from each other for cutting coal from the mine face during reciprocation of the coal planer in a direction parallel to the mine face, and with a bottom knife adapted to cut into the sole of the mine gallery. 13 claims, 5 figures.

55677 West Virginia Univ. professors work for electrical safety. Mason, R.H. *Coal Min. Process.;* **14**: No. 5, 107-108, 117(May 1977).

Extensive studies being conducted under grants from the U.S. Bureau of Mines to improve the safety of all electrical equipment in underground mines are discussed. Several aspects of this research undertaken by West Virginia University professors are examined, including primary cable problems, periodic inspections, and monitoring of circuit breakers. Importance of this research is underscored by the fact that 66% of all mine fires and 21% of all methane ignitions investigated through 1972 can be attributed to electrical sources.

55678 Poland's coal and lignite mining programme will ensure its future energy requirements. *Min. Mag.;* **136**: No. 4, between p 247 and 259(Apr 1977).

An overview of Polish coal and lignite mining is presented with a description of some of the likely future developments, and a presentation of a more detailed account of an important lignite project in Poland and a modern Polish colliery in the Rybnik coal mining region centered around Katowice. Coal and lignite production in Poland during the years 1960, 1970 and 1975 is presented in tabular form, and Polish exports of coal (the country is the world's second biggest exporter) are examined.

55679 Model studies of mine roadway deformation. Brook, N. (Leeds Univ, Engl). *Min. Eng. (London);* **136**: No. 191, 375-384(Apr 1977).

The development of a system for modeling the deformation of a mine roadway is reported, and this is compared with the deformation of an actual roadway at Prince of Wales Mine. A method of obtaining a detailed strength log of fractured borehole core is presented, and the results used to design the models. An improved method of support is tested by modeling.

55680 Some practical experiences using sulphur hexafluoride as a tracer gas to determine leakage rates in mine ventilation systems, mainly in the South Nottinghamshire area. Wann, J.M.R.; ter Area, E.; Milner, A.; Wynne, A. (Natl Coal Board, Doncaster Area, Engl). *Min. Eng. (London);* **136**: No. 191, 391-404(Apr 1977).

Sulfur hexafluoride was used as a tracer gas to determine gas leakage rates between shafts of neighboring collieries, through old workings, and to measure leakage rates through stoppings. Both steady release and pulse release techniques were used. The physical characteristics of sulfur hexafluoride, coupled with a lower limit of detection of approximately 1 part in 10^{12} using the electron capture detector, indicate that it is likely to be superior to other gases that have previously been used as tracer. Some of its advantages have been demonstrated in a number of practical exercises underground, under varying conditions. 14 refs.

55681 Coal mining electrical and electronic engineering. Wallace, C.K. (John Davis and Son Ltd, Derby, Engl). *Colliery Guardian;* **225**: No. 4, between p 187 and 198(Apr 1977).

Various aspects of electrical and electronic engineering as applied to mining, with particular reference to longwall systems of coal extraction, are covered. The use of flameproof transformers and switchgear, so far largely confined to Longwall type of mining, is examined along with flameproof circuit breaker assemblies, cable handling and motor control gear for the control and protection of underground machines in the U.K. The problems of electromechanical and thermal overload protection are also dealt with.

55682 Installation of the Anderson Strathclyde buttock shearer North Yorkshire area. Williams, I. (Rotwell Colliery, Engl). *Colliery Guardian;* **225**: No. 4, 224-228(Apr 1977).

After a brief review the history of Rothwell Colliery near Leeds, Yorkshire, installation and salient features of the Anderson Strathclyde buttock shearer is described. Advantages of the machine include a reduction in the face team of six men per shift, a substantial decrease in dust counts, and a greater cutting speed with the resultant reduction in the amount of coal fines.

55683 Brown coal: open pit technique reaches new order of magnitude. Tilmann, W. *Glueckauf;* **113**: 317-321(17 Mar 1977). (In German).

Developments in equipment and methods in the Federal Republic of Germany, other countries of the European Community, and some European countries, are reported.

55684 Mining engineering's annual review of coal and industrial minerals. I. Saperstein, L.W.; Terchick, A.A.; Matoney, J.P.; Ramani, R.V.; Wilson, E.B.; Murray, R.E. (Pa State Univ, University Park). *Min. Eng. (N.Y.);* **29**: No. 3, between p 33 and 51(Mar 1977).

This six-part review contains articles on surface mining, underground mining, coal preparation, coal utilization, health and safety, and research and development.

55685 Roadway drivages and drilling in coal mines. Straughan, J. (Dosco Overseas Eng Ltd). *Colliery Guardian;* **225**: No. 3, between p 149 and 156(Mar 1977).

The alternative techniques and some of the equipment currently being used in roadway drivage in British coal mines are examined. Not all the techniques are necessarily applicable to conditions in the U.S., due to differing geological circumstances, but in general the principles are considered to be of interest to American mining engineers. The range of chain-type and rotary head cutting-loading machines is highlighted. Also discussed is the tunneling machine, a recent development in high capacity heading machines.

55686 Ranging-arm shearer: its introduction in the Barnsley seam at Frickley Colliery. Downes, E.J. (Doncaster Coll of Technol, Engl). *Colliery Guardian;* **225**: No. 3, 157, 159-163(Mar 1977).

The introduction of the ranging arm shearer with the Barnsley seam at Frickley Colliery is described. Frickley is a 1-million-ton colliery situated some 9 miles from Doncaster. The seams being worked are the Barnsley, Dunsil and Cudworth. In order to make a comparison and thus to prove what success or failure this system of work has had and will have in the future, two production units have been selected, B.70's and B.71's. Both units have practically the same environmental conditions within the same seam, B.70's having no ranging-arm shearers, whereas B.71's has two such machines. To make the comparison as fair as possible a period of three months in the life of each unit was chosen.

55687 Foreseeable developments of mining techniques in large coal-producing countries. Ellie, G. (Charbonnages de Fr). *Rev. Energ.;* **28**: No. 291, 78-88(Feb 1977). (In French).

The research to improve the productivity of coal mining operations basically tend toward finding techniques for reducing the personnel, either by doing away with certain tasks, or by mechanizing and automating certain operations or, yet again, by improving the reliability of the methods and equipment. For conventionally mined deposits such as, first of all, strikes in which the coal is extracted by known open-pit mining processes and also shallow mines having regular horizontal layers, the advances made in modernizing the methods and to which the major world producers are devoting their efforts are especially in the design of cutting, transport and pit propping equipment in order to arrive at the less workings. The question of exploiting the large coal reserves in difficult and deep deposits is considered. Problems of operational strategy, remote control and monitoring of underground installations are indicated.

55688 Principal lines of development of science and technology in the tenth five-year plan period. Grin'ko, N.K. (Minugleprom, USSR). *Ugol;* No. 1, 10-20(Jan 1977). (In Russian).

The main lines of development of science and technology in the Soviet coal industry in the 1976-1980 period are summed up. The scientific problems are solved by 36 industrial branch research and development institutes with 24,000 staff members including 10,000 people directly involved in research. Various tasks to improve mining technology, transportation, safety, coal dressing, coal mining machinery, economics and management are outlined.

55689 Modern materials for underground support. McChesney, M. (Univ of the Witwatersrand, Johannesburg, S Afr). *J. S. Afr. Inst. Min. Metall.;* **77**: No. 5, 114-118(Dec 1976).

The properties required of a support material for underground tunnels are discussed and, because concrete is both economical and easy to apply, a number of new reinforcing materials for concrete are examined with particular reference to these properties. From about thirty tests on different types of reinforced concrete, it is concluded that the addition of polymer to a concrete does not seem to influence the post-failure behavior, of the concrete and the only benefit to be achieved by this addition is to increase its flexibility (or to decrease it, depending on the polymer). Steel fibers tend to increase both the strength and stiffness of the concrete, but polypropylene fibers, although having definite load-carrying capacities, provide nonstable failure, also known as brittle failure. The best result is obtained for concrete reinforced with steel wire: the post-cracking strength is very good and is maintained for a considerable deformation.

55690 Study on the outburst of gas and coal: on the geological structure conditions and back effect of blasting. Ujihira, M.; Hashimoto, K. *Nippon Kogyo Kaishi;* **92**: No. 1066, 791-796(Dec 1976). (In Japanese).

Correlation coefficients between the numbers of outbursts which occurred in various collieries in Ishikari Coal Field, Hokkaido, Japan from 1926 to 1970 and 13 types of geological characteristic values of each colliery are shown. According to the consideration of calculated correlation coefficients, it is confirmed that all characteristics which are of geological complex structure have a high correlation with the frequency of outburst incidence. Blasting experiments are made on a small scale to study the back effect of blasting which is considered one of the important causes of outburst incidence. In the experiments, the blasting conditions are selected to simulate a site where the geological structure has a crossed and complicated formation, with a fragile and weak coal seam located at the back of the charge hole tip. As a result of the experiment, quantitative relations between the charged explosive volume and back effect and also between the charge hole and back effect are obtained. For example when the charged explosive volume (L) and the length of charged hole (l) are increased respectively, the expansion rate of back material (eta) which is one of the important measurement of the back effect was observed to increase in proportion to L$sup 0.35$ $sup to$ $sup 0.4$ and l$sup 1.9$ $sup to$ $sup 2.4$. These facts indicate qualitatively that both overcharging and long length hole blasting may give rise to gas outburst at coal mines. 11 refs.

55691 Shield support practice in German coal mining. IrresberGer, H. (Bergbau Forsch, Essen, Ger). *Berg- Huettenmaenn. Monatsh.;* **121**: No. 12, 499-506(Dec 1976). (In German).

The six-year development in technical improvements is reviewed, and various methods are evaluated regarding longwall and hanging wall mining. Comparisons with the frame-type support method are made for performance. 5 refs.

55692 Selection of the shape of cross-section of mine workings driven by combines. Iverovskii, E.N.; Levin, A.M. (Dongiprouglemash, USSR). *Ugol;* No. 12, 5-8(Dec 1976). (In Russian).

An analysis of the interrelation between the shape of cross section of a mine working and the design of a rock driving combine is presented. It is found that it is more economical to drive arched tunnels by means of a combine equipped with berm organs than to use a combine to drive circular tunnels.

55693 Subsidence of packing rocks under pressure. Vasil'ev, M.P. (Karaganda Sci Res Inst of Coal, USSR). *Ugol;* No. 12, 8-11(Dec 1976). (In Russian).

The possibility of predicting stowing rock subsidence under roof pressure is investigated, substantiated and checked. An engineering method of calculation of subsidence following mining of gently sloping seams with pneumatic and hydraulic stowage with gob rock is worked out.

55694 Stability of supports of mine workings under seismic loads. Shirokov, A.P.; Sinel'nikov, L.M.; Kuznetsov, V.G. (Kuznetsk Sci Res Inst of Coal, USSR). *Ugol;* No. 12, 11-14(Dec 1976). (In Russian).

Results of an investigation are presented, the purpose of which was to determine comparative stability of different types of supports, used in coal mines, with respect to dynamic loads. Recommendations are given on strengthening supports in seismically hazardous conditions.

55695 Determination of the probability of loosening the undermined coal seams in the light of the underground observations and theoretical consideration. Staron, T. *Przegl. Gorn.;* 32: No. 12, 529-536(Dec 1976). (In Polish).

Investigations carried out and associated with the possibility of determination of expected effects of undermining are presented. On the basis of underground observations of underminings in collieries of the Upper Silesian Coalfield, formulas for calculation of the probability of loosening the undermined seam are deduced with the use of probability calculus and reliability theory. The numerical value of the parameter characterizing the effect of undermining is determined on the basis of underground observations. The deduced relationship is compared with data obtained from formulae of other authors. Finally, conclusions of theoretical and practical nature are given. 5 refs.

55696 Determination of the optimum depression in methane-drainage boreholes in mines. Cias, Z. *Przegl. Gorn.;* 32: No. 12, 543-547(Dec 1976). (In Polish).

Results of many years' studies on the effect of depression in methane-drainage boreholes on the gas yield of these boreholes are presented, and the empirical formula expressing this relation is given. On the basis of the analysis of factors of the formula geotechnical conditions of the methane-bearing deposits are determined as enabling the assessment of the structure of deposit and the choice of appropriate parameters of methane drainage. An optimum value of depression for the condition of Moszczenica colliery is determined which may be applied under geological and gas conditions of remaining gassy mines of the Rybnik Coal Area. 2 refs.

55697 Terminology and classification of qualitative characteristics of coal mines. Braitsev, A.V. (Min Inst im. A.A. Skochinskii, USSR). *Ugol;* No. 11, 20-24(Nov 1976). (In Russian).

Some basic terms relative to coal mining are defined and a classification scheme of underground coal mining technology is presented in the form of a table and a diagram.

55698 Dismantling and installation of longwall face with powered supports. Mitra, D. (Sofremines (I) Ltd, Calcutta, India). *J. Mines, Met. Fuels;* 24: No. 10, 313-316(Oct 1976).

In Indian coal mines the most prevalent hoisting system has been by single deck cages either of one or two tub type. Use of mine car facilities is uncommon and special cages for lowering bulky material are very rarely used. There is a growing awareness of the need to introduce a third-generation longwall mining system here. Such a high level of mechanization would require adequate handling facilities for equipment, which are often bulky as well as heavy. This article deals with this problem based on the experience gained in the European mines. 3 refs.

55699 Investigation into strata behaviour around an experimental longwall caving face in Jharia coalfield. Maung, H.M.; Banerjee, S.P. (Indian Sch of Mines, Dhanbad). *J. Mines, Met. Fuels;* 24: No. 9, 283-289(Sep 1976).

Strata control investigations were carried out in an experimental longwall caving face in Monidih Colliery in India's Jharia Coalfield. Convergence measurements on gate roads ahead of the face showed an undulatory type of strate movement with the zone of pronounced movement lying within 20 m ahead of the face. The maximum closure of the gate road behind the face was 10% of the extracted seam height. The nature of convergence at the face agrees with observations made by other workers in India. Convergence studies also were conducted during the finishing stages of the face and it was found that suddenly increased roof span can cause greatly increased convergence at the face as well as on the gate road ahead of the face. 14 refs.

55700 Extracting coal standing on pillars by modified longwall method. Skowron, L.K.; Burszczyk, H. (Bharat Coking Coal Ltd, India). *J. Mines, Met. Fuels;* 24: No. 8, 249-256(Aug 1976).

The upper seams of India's Jharia Coalfield, containing the best coking coal, have been exploited leaving hundreds of millions of tonnes of coal standing on pillars. These reserves are partly wasted by fire, partly by working lower seams, etc., but a large amount of high grade coal is still available for extraction. A method is described of extracting this coal by a modified longwall technique. When properly implemented the method permits a clean and safe extraction of coal standing on pillars. Both advantages and limitations of the method are discussed.

55701 Point load strength of some Indian rocks. Verma, B.S.; Singh, D.P.; Mishra, R.N. (Banaras Hindu Univ, Varanasi, India). *J. Mines, Met. Fuels;* 24: No. 8, 257-264, 280(Aug 1976).

Determination of the strength properties of rocks is tedious and time-consuming and hence there has always been a need for developing a simple method of establishing the strength index. A literature survey undertaken for this purpose revealed that the point load strength index may be a step in this direction. An effort has been made to establish a facility for determining the point load strength in the Rock Mechanics Laboratory of the Department of Mining Engineering, Banaras Hindu University, and to establish the relationship between the point load strength and compressive strength of various Indian rocks. The results so far obtained are discussed in this paper. 16 refs.

55702 Improvement of designs of sets for preparatory workings in Moscow basin conditions. Popov, V.L.; Karetnikov, V.N. (Tula Polytech Inst, USSR). *Ugol;* No. 7, 49-54(Jul 1976). (In Russian).

A calculation method is presented on the basis of which new designs of sets with improved carrying capacity have been worked out. The computer-aided design method considers any test consisting of a finite number of elements of differing curvature and rigidity conjugated in any way between each other and carrying any arbitrary load. Several versions of improved annular, circular, polygonal, and barrel-shaped sets are described.

55703 Metricating the crude oil and natural gas industry. Moore, P. (Shell Can Ltd, Calgary, Alberta). *J. Can. Pet. Technol.;* 15: No. 1, 41-44(1976).

A fundamental change in the time-honored system of measurement in use in the petroleum industry will take place during the next three years. Vigorous planning is now in progress for metric conversion of the industry in harmony with the nationwide conversion plan of the Metric Commission. Practical units for each application have been selected from the range available in the International System of Units (SI)--the most modern metric system and the one adopted by the Government of Canada. The choice of the mole for the measurement of gas reserves and production is discussed in some detail. The plan for the conversion of the industry is being developed by critical-path methods and the preliminary plan calls for the adoption of SI for the language and instruments of measurement sometime in 1978. 6 refs.

55704 Modern mine ventilation installations. Seiler, W. *AEG-Telefunken Prog.;* No. 4, 117-119(1976).

The growing concentration of main ventilation systems in the German coal fields has decisively influenced the development of the fans and their drives. The increased significance of the central mine fans for wide spheres of underground mining require extensive control and monitoring of the machines. A survey of main-shaft ventilation installations is followed by a description of a modern installation for which the latest control technology has been employed.

55705 Geamatic 2000 I, a new automation system for underground mining installations. Luetkenhaus, H.J. *AEG-Telefunken Prog.;* No. 4, 124-127(1976).

The advancing mechanization in mining as well as the rising demand concerning safety and ease of servicing of the electrical apparatus necessarily lead to the use of better techniques in the field of underground mining. The Geamatic 2000 i automation system presented here is specially tailored to the interest of mining and is used for the control of installations and the measurement and transmission of information.

55706 Trolley-wire-operated underground locomotive with manual and remote control, including fully automatic control and speed regulation. Mittmann, U. *AEG-Telefunken Prog.;* No. 4, 128-132(1976).

AEG-TELEFUNKEN has supplied 16 trolley-wire-operated locomotives, Type HF 3 D, with manual and remote control, for a coal mine in the Ruhr District. The locomotives are equipped with an electronic controller. Since they were put into service in 1975,

they have been meeting the targeted transportation objectives for a fully automatic underground haulage system.

55707 Integrated method of determination of optimal reliability indices of the transportation and technological network of a coal mine. Zel'vyanskii, A.S.; Kaufman, L.L.; Miroshnikov, S.I. (Donetsk Sci Res Coal Inst, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Gorn. Zh.;* No. 6, 3-8(1976). (In Russian).

The proposed method is based on the use of partial derivatives. In solving problems of optimal design, this method permits determination of the most advantageous level of reliability of a technological system and an optimal distribution of reliability indices among its units and elements.

55708 Control of stress distribution around mine workings. Babiyuk, G.V. (Kommunar Min-Metall Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Gorn. Zh.;* No. 6, 15-18(1976). (In Russian).

Results of laboratory investigations, using the optical polarization method, into the control of distribution of stresses around mine workings by means of slots are presented. By means of slots, changes in the state of stress of rocks and improvement in the stability of the bare rock wall of a mine working are obtained. The most expedient schemes of distribution of slots for workings of different cross sections (circular, ellipitical, rectangular, and vaulted), depending on the initial stress field, are determined. Methods of control of distribution of stresses by changing parameters of slot relief (length and rigidity of the slot, its location in the contour of the working) are investigated.

55709 Expediency of using monorail suspended railroads with locomotive traction. Surkov, L.P.; Alakseevskii, I.G. (Sverdlovsk Min Inst im. V.V. Vakhrusheva, USSR). *Izv. Vyssh. Uchebn. Zaved., Gorn. Zh.;* No. 6, 108-110(1976). (In Russian).

The expediency of using monorail suspended railroads with locomotive traction in coal mines with complete and partial conveyor transport, and with hydraulic coal transportation, is considered. The possibility of using monorail suspended railroads in mountainous local relief to transport a mineral from the mining area to the railroad, consumption or processing center, is pointed out. A method of calculation for the selection of the most economic locomotive haulers for monorail railroads is presented.

55710 Some problems of formalization of the process of introduction of research results into production. Gimel'shein, L.Y. (Kuzbass Polytech Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Gorn. Zh.;* No. 7, 124-131(1976). (In Russian).

A formalized approach to the drawing up of plans for the organization of the process of introduction into production practice of technical solutions, developed on the basis of the results of scientific research, is proposed. A classification of organizational principles of introduction of technical solutions, and a structure of characteristics determining the process of their introduction is given.

55711 Organization of data search and data representation in a coal mine information retrieval system. Faierman, I.P. (Giprougleavtomatizatsiya, USSR). *Izv. Vyssh. Uchebn. Zaved., Gorn. Zh.;* No. 7, 151-156(1976). (In Russian).

Problems of development of an information search language, creation of search methods of information retrieval sheets, formation of an information query and search order are considered. A standardized form is described, on the basis of which information retrieval sheets are compiled. They are issued to subscribers as answers to their queries.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 55552, 55582, 55684, 55688, 55705, 55707, 55709, 55776

55712 (FE—2003-18a) Chemical characterization, handling, and refining of SRC to liquid fuels. Final report on Task 3: handling characteristics of SRC. Clump, C.W.; Levy, E.K. (Lehigh Univ., Bethlehem, Pa. (USA)). 20 Jan 1977. Contract EX-76-C-01-2003. 75p. Dep. NTIS, PC A04/MF A01.

The storage and handling characteristics of solvent refined coal (SRC) were investigated with emphasis placed on properties important in the use of SRC as a solid fuel in existing coal-fired power plants. The results of a comprehensive review of research performed on SRC utilization for power plant applications are presented. Experiments on SRC consolidation and particle adhesion in pneumatic transport are described. The first two of these phenomena are responsible for problems encountered in recent studies of grinding, bin flow, pneumatic transport, and combustion.

55713 (MERC/RI—77/2) Development of coal-feeding systems at the Morgantown Energy Research Center. Hobday, J.M. (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). Aug 1977. 36p. Dep. NTIS, PC A03/MF A01.

The Morgantown Energy Research Center (MERC) has developed a variety of systems since 1945 for feeding crushed and pulverized coal into coal conversion reactor vessels. This paper describes their part and current work on these systems including pneumatic methods for feeding pulverized coal, slurry feeders, and coal pumps, methods for steam pickup, and a method for drying a water-coal slurry in a steam-fluidized bed subsequent to feeding the coal into a reactor vessel.

55714 Measurements of coal slurry concentration in haulage pipelines by nuclear techniques. Verbinski, V.V. (Science Applications, Inc., La Jolla, CA); Elias, E.; Patricelli, F.; Gozani, T. *Trans. Am. Nucl. Soc.;* 26: 159(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55715 Transmission of solids by pipeline. Wood, G.T. (Natl Coal Board, West Area). *Min. Eng. (London);* 136: No. 191, 405-412(Apr 1977).

An account is given of the experience of pumping slurries in the Western Area National Coal Board. A discussion is presented on how these techniques can be improved and suggestions on applications which may be to the benefit of the mining industry are made. Long distance pumping of bentonite, pulverized fuel ash, cement, and coal is detailed, and pumping down dual pipelines at Chatterley Whitfield Colliery is analyzed.

55716 Technological analysis of conditions of separation of Polish gas and power coal slurries by flotation. Sablik, J.; Bednarska, J.; Olszowka, J. *Przegl. Gorn.;* 33: No. 1, 22-31(Jan 1977). (In Polish).

Results of tests carried out at the Central Mining Institute and aiming at the determination of optimum parameters of separation of gas and power coal slurries by flotation in seven selected collieries are presented. On the basis of results the flotability of particular coals is estimated using the flotability of coking coal as reference system. 13 refs.

55717 Effect of support on an inclined measuring tank on the load on measuring probes of batching tank scales in a skip pit bottom. Bura, L. *Przegl. Gorn.;* 32: No. 12, 13-18(Dec 1976). (In Polish).

Two ways of supporting the tank loaded with coal are analyzed. They area featured by a measuring support transferring the load in the direction parallel to the tank bottom or to the force of the weight of coal. It was shown that the characteristic: load on the measuring support/weight of coal in the tank during the cycle of its filing and emptying may render difficult getting the maximum capacity of the skip winder. Dynamic disturbances of the batch measurement are found at the bottom end position of the antibreakage plate wandering along the tank, which is caused by the deviation of the plate from the bottom of the tank. The effect of the flow intensity of coal to a tank equipped with such a plate on the weight of coal batch being reduced owing to the mentioned dynamic disturbances is explained. 1 ref.

55718 Rubber pipe for hydraulic stowing. Ratman, J. *Przegl. Gorn.;* 32: No. 12, 18-20(Dec 1976). (In Polish).

The design of a rubber pipe type RKGS (flanged rubber pipe, stabilized) for hydraulic stowing is presented together with its technical parameters and laboratory tests and industrial applications in mines which confirmed its suitability.

55719 Tests and aerodynamic probing of TSP2 cyclones with a louvered swirler. Rezdik, V.A.; Tikhomirov, V.A.; Prokofichev, N.N. *Energomashinostroenie;* No. 12, 4-6(1976). (In Russian).

The TsP2-1500 cyclones are tested for the efficiency of collection of finely dispersed anthracite dust and the TsP2-2500 for collection of the abrasive dust of Ekibastuz coal from the drying agent when the exhaust pipe is provided with louvered and three-vane swirlers. It is shown that efficiency is improved by 1.5% compared with TsN15 cyclones and there are considerable savings in metal.

55720 Statistical analysis of patents for determination of the world level of development of coal pulverization equipment at steam power plants. Kaminskii, L.V.; Dronov, Y.D. *Energomashinostroenie;* No. 11, 45-46(1976). (In Russian).

Trends in the development of coal grinding equipment in different countries of the world are determined relying on a statistical analysis of patents. It is shown that the most promising trend is the developmewnt of medium-speed mills and fan-mills.

55721 Principal tasks and lines of development in higher educational establishments of studies concerning transportation in coal mines in the tenth five-year plan period. Shtokman, I.G. (Donetsk Polytech Inst, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Gorn. Zh.;* No. 7, 82-87(1976). (In Russian).

The mining colleges in the USSR that offer courses in mine transportation and the specialized subjects taught and research projects undertaken there are surveyed. In the 1976-1980 period, the main research efforts will be directed to belt conveyor transportation. Conveyor transportation along horizontal workings is to be increased to 30% of the total, and along inclined workings to 100% by 1980. Special attention is paid to the development of steep-slope, multi-drive, and flexible belt conveyors. Slurry piping problems are studied.

COMBUSTION

REFER ALSO TO CITATION(S) 55642, 55650, 55651, 55735, 55804, 56295, 56316, 57319, 57321, 57325

55722 (CONF-770530—2) **High temperature coal and slurry combustor according to a one-dimensional flow model.** Chung, P.M.; Smith, R.S. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 9p. Dep. NTIS, PC A02/MF A01.

From 16. engineering aspects of MHD symposium; Pittsburgh, Pennsylvania, United States of America (USA) (16 May 1977).

A steady state, one-dimensional analysis for a high temperature coal or oil-coal slurry combustor is presented. An existing solution of solid fuel ignition is employed to describe the ignition of the coal particles. A one-dimensional flow model with radiative heat loss is then constructed to describe the subsequent vaporization and combustion of oil, devolatilization, combustion, and gasification of the coal. Combustion is considered to take place either at a flame sheet in the diffusion layer surrounding each particle or at the particle surface. The combustion products are considered to be redistributed in the main gas stream of the combustor according to simplified devolatilization rate law is formulated, which incorporates in a tractable manner the various competing reactions within the coal particle. Data presented apply to combustion of coal and a kerosene-coal slurry.

55723 (FE—2018-6) **Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, 11 September—10 December 1976.** Houser, T. (Western Michigan Univ., Kalamazoo (USA). Dept. of Chemistry). Mar 1977. Contract EX-76-C-01-2018. 8p. Dep. NTIS, PC A02/MF A01.

A study of the reaction mechanism which leads to NO formation from fuel-nitrogen by determining the rates and mechanisms of pyridine pyrolysis and cyanogen oxidation was continued. The emphasis was shifted to the determination of the rate of formation of HCN since in previous studies it was found to be the major product containing the nitrogen during pyridine pyrolysis at higher temperatures (essentially 100% of the nitrogen appeared as HCN at 1100°C). Because of the unreliability found in data from HCN chromatographic peak heights, the determinations are being done by wet chemical methods and these experiments are just underway. The oxidation of cyanogen has concentrated on a material balance. Using a one meter gas cell, infrared spectra of the products indicate that CO_2 is the only major oxidation product in the 950-1050°C range. Small amounts of N_2O were found but no NO was observed; thus, it appears that most of the nitrogen from the reaction ends up in the elemental form. The significance of these observations to the overall project is that NO/sub x/ formation from fuel-nitrogen appears minor if fuel pyrolysis to CN type species takes place before oxidation. However, since fuel-nitrogen does contribute significantly to NO/sub x/ formation during coal combustion, the oxidizer must influence the products during the pyrolytic stage.

55724 (FE—2018-7) **Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, December 11, 1976—March 10, 1977.** Houser, T. (Western Michigan Univ., Kalamazoo (USA). Dept. of Chemistry). Jun 1977. Contract EX-76-C-01-2018. 7p. Dep. NTIS, PC A02/MF A01.

A study of the reaction mechanism which leads to NO formation from fuel-nitrogen by determining the rates and mechanisms of pyridine pyrolysis and HCN formation was continued. The emphasis was continued on the determination of the rate of formation of HCN in an inert atmosphere since in previous studies it was found to be the major product containing the nitrogen during pyridine pyrolysis at higher temperatures. Using a picric acid-colorometric method for the analysis of HCN, the ratios of moles HCN produced/mole pyridine consumed have been determined at 950 and 1000°C. From the results it appears that HCN is formed through a consecutive reaction mechanism, since the ratio increases with reaction time. These studies are being continued.

55725 (FE—2325-14) **Testing, identification, and evaluation of commercial and "advanced experimental" materials and coatings under design conditions simulating fuel power cycle combinations. Task II. Evaluation of heat exchanger materials for use in coal-fired fluidized bed combustion environment. Monthly technical progress report No. 14.** Hall, A.M. (Battelle Columbus Labs., Ohio (USA)). 2 Aug 1977. Contract EX-76-C-01-2325. 13p. Dep. NTIS, PC A02/MF A01.

The long-term combustor run was completed on July 10, 1977. During the July period, average bed temperature was 1610°F, superficial gas velocity was 7.4 ft/s, while the SO_2 content of the flue gas was 560 ppM. During the 1500-hour run, specimen temperatures on the bed probe ranged from 1240 to 1430°F, while the specimen temperatures on the freeboard probe were 1160 to 1525°F. No gross deposit collected on the bed probe, but a pinkish-white deposit collected on the sides of the freeboard probe. Weight-loss measurements showed that alloys P9 and IN671 wasted linearly with time at high rates. The other alloys exhibited parabolic wastage with time. The data indicated that wastage rates for 310 SS, 347 SS, 18-18-2 SS, and FSX 414 would be 2 to 3 mils/year in the freeboard and 4 to 6 mils/year in the bed. The specimens exposed 500 hours showed chromium depletion, except those specimens provided with a diffused aluminum coating. None of the alloys appeared to have been sulfidized. After 1100 hours, the 316 SS bed-cooling tubes were replaced because of severe leakage. The metal wastage on these tubes was found to vary with position in the bed, and perhaps with tube temperature.

55726 (FE—2412-T-1) **Particulate analysis instrumentation for fluidized-bed combustion systems.** Swain, D.M. (Leeds and Northrup Co., North Wales, Pa. (USA)). Oct 1976. Contract EX-76-C-01-2412. 36p. Dep. NTIS, PC A03/MF A01.

Leeds and Northrup Company was awarded a R and D contract on May 4, 1976, to develop a particulate analysis instrument for fluidized-bed combustion systems. The purpose of this instrument is to accurately measure on-line particulate loadings and size distributions in hot gas streams of such systems. The first task of this program was to conduct an applications analysis of optical low-angle forward scattering of particles in high pressure (up to 10 atms.) and high temperature (1500° to 2000°F) gas streams and to determine the optical configuration for such an instrument. This task has been completed and the results are presented. It has been determined that it is feasible to design an on-line optical instrument for measuring particles 1 to 50 microns in diameter and compatible with duct sizes varying from 1 to 12 inches I.D.

55727 **Calculating heat content from ash percentages.** Shantz, R. (NM Bur of Mines and Miner Resour, Socorro). *Coal Min. Process.;* **14**: No. 5, 112, 114(May 1977).

Determination of coal heat content by calorimeter is considered to be comparatively costly and time consuming, especially for coal preparation studies. Consequently, a project supported by the New Mexico Energy Resources Board and federally funded was completed by the New Mexico Bureau of Mines and Mineral Resources. The project scientists made an attempt to correlate the heat content of the New Mexico coals being studied with their ash analyses. The author describes this method of determining Btu content, which results in significant cost savings and probably can be extended to other western coals. 4 refs.

55728 **Radioactive residual matter. II.** Gauvenet, M. (Commis a l'Energie At, Fr). *Rev. Energ.;* **28**: No. 292, 152-159(Mar 1977). (In French).

The preoccupation of charting radioactivity wherever it is found has led to the discovery that some natural products used up until now without any particular precautions are in fact radioactive and should therefore be treated according to the same rules as residual matter in nuclear industry. For example, it has been noted that coal power stations reject gases and dust which are radioactive and that after combustion large amounts of residual matter are left in which radio-activity is concentrated. The principles used by nuclear industry for effluents and radio-active waste are noted, and a complete chart of the various means utilized to eliminate, store and transport low and medium-level radio-active residual matter is established.

55729 **Investigation of aerodynamics, ignition and burnout of spray in the furnace of a BKZ-420-140-1 boiler with twinned vortex burners of ekibastuz coal.** Goncharov, A.I.; Marshak, Yu.L. (Heat Eng Inst, Sib, USSR). *Teploenergetika (Mascow);* No. 12, 20-27(Dec 1976). (In Russian).

The furnace is equipped with 12 twinned vortex burners mounted on opposed lateral walls in one tier. A diagram of the furnace is given, its characteristics are described. The methods and results of aerodynamic, ignition and burnout tests are presented. It is concluded that the investigation burners ensure good aerodynamics, stable ignition, and intensive burnout at the initial section.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 55664, 55678, 55688, 56976

55730 (CONF-751113C—1) **Capital for coal development.** Wilson, W.W. (Continental Illinois National Bank and Trust Co., Chicago (USA)). 1975. 13p. Wilson, Continental Illinois National Bank and Trust Co. of Chicago, IL.

From Conference on coal energy; Washington, District of Columbia, United States of America (USA) (21 Nov 1975).

The following topics are discussed: capital needs of the coal industry; sources of capital for coal development; financing techniques; and external constraints on coal development financing.

55731 (IS-ICP—46) **Economics of mining coal in Iowa.** Boehlje, M.; Libbin, J.D. (Iowa State Univ. of Science and Technology, Ames (USA). Energy and Mineral Resources Research Inst.). Mar 1977. 36p. Dep. NTIS, PC A03/MF A01.

The Department of Economics of Iowa State University has three major areas of research responsibility as a part of the Iowa Coal Research Project: (1) economic analysis of the feasibility of a major Iowa coal-producing industry, (2) analysis of the legal dimensions of mining coal in Iowa, and (3) economic analysis of the coal transportation network in Iowa. This paper summarizes research results from the economic feasibility study in an Executive Summary format. Distribution is intended for persons on and off the Iowa State University campus who are interested in the basic results but are not concerned specifically with the research methodology employed; consequently, the paper does not discuss in detail the mathematical model used in the feasibility analysis or the development and justification of the input data. Rather, the purpose of this discussion is to present the economic climate in which the Iowa coal industry competes and the general results of the economic analyses performed to date. Additional work continues in the Department of Economics in all three areas noted. 20 references.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 55623, 55657, 55680, 55681, 55684, 55687, 55688, 55694, 55701, 55704, 55708, 55779, 56923, 56938

55732 (PB—264438) **Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume I. Development and application of cost model. Final report.** DiCanio, D.G.; Nakata, A.G.; Colvert, D.; LaVeque, E.G. (FMC Corp., Santa Clara, Calif. (USA). Engineered Systems Div.). Sep 1976. Contract J0255031. 205p. NTIS PC A10/MF A01.

The report describes a computer-based model for estimating the tangible costs of injuries and deaths from work-related accidents in underground coal mines. The study undertook to identify and quantify the elements of accident costs, including field visits to coal mines, insurance carriers, and public agencies. The mathematical models developed for each tangible element of accident cost are presented in Volume I of the report. Application of the model to a data base of 9,286 accidents which occurred in underground bituminous coal mines during 1974 yielded a total of $56,900,000 in tangible costs to industry, mining families, and public agencies. Loss of income to the families of miners injured or killed in these accidents accounted for 47 percent of the total.

55733 (PB—264439) **Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume II. Program user manual. Final report.** DiCanio, D.G.; Nakata, A.H.; Colvert, D.; LaVeque, E.G. (FMC Corp., Santa Clara, Calif. (USA). Engineered Systems Div.). Sep 1976. Contract J0255031. 156p. NTIS PC A08/MF A01.

See also Volume 1, PB—264438.

A listing of the computer programs which comprise the model and instructions for using the programs are presented in this volume.

55734 (PB—264440) **Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume III. Supporting data. Final report.** DiCanio, D.G.; Nakata, A.H.; Colvert, D.; LaVeque, E.G. (FMC Corp., Santa Clara, Calif. (USA). Engineered Systems Div.). Sep 1976. Contract J0255031. 104p. NTIS PC A06/MF A01.

See also Volume 2, PB—264439.

Statistical distributions of mining family characteristics, data on 95 miners killed in underground accidents, and other basic data used to develop the model are presented in this volume.

55735 Some studies in the prevention of spontaneous ignition of coals in stacks. Roy, T.N.; Nandi, S.P. (Cent Fuel Res Inst, Dhanbad, India). *J. Mines, Met. Fuels;* **24**: No. 11, 358-359(Nov 1976).

Although much research was done on the causes of spontaneous ignition of coals and its prevention in stacks, no efficient method has so far been developed to prevent it. This mainly attributed to the difficulty of applying laboratory results to the practical problems associated with such materials as coal, and also to the preponderance of physical factors over chemical ones. Results of research on the spontaneous combustion characteristics of some Indian coals known to be susceptible to this type of combustion are presented. The study also includes experiments conducted on several inhibitors of spontaneous combustion. 1 ref.

55736 Sudden coal and gas bursts. ways to solve the problem. Khodot, V.V.; Ivanov, B.M.; Feit, G.N. (Min Inst im. A.A. Skochinskii, USSR). *Ugol;* No. 10, 13-19(Oct 1976). (In Russian).

A general review of the ideas regarding the causes and mechanisms of gas dynamic phenomena in coal mines is presented. A systematization of these phenomena is proposed and the principal lines of development of the theory of sudden coal and gas bursts are evaluated. 11 refs.

55737 Role of porous and fissiparous structure of coal in creating burst hazard situations and in mechanisms of sudden coal and gas bursts. Kanin, V.A. (Donbass Ukr SSR Min Inst). *Ugol;* No. 10, 19-22(Oct 1976). (In Russian).

Specific features of the stressed and strained state of the edge part of a gas-saturated seam consisting of tectonically prepared coal are considered. A conceptual model of formation of a potentially dangerous medium and creation of a burst hazard situation is presented. Possible lines of devising a general method of predicting burst hazard situations are considered.

55738 Bearing pressure as a factor reducing seam burst hazards. Batmanov, Yu.K.; Shumeiko, V.I.; Poznyakov, G.G. (Donbass Ukr SSR Min Inst). *Ugol;* No. 10, 29-31(Oct 1976). (In Russian).

Technical and technological solutions having an effect on the magnitude and character of formation of a bearing pressure zone in front of the working face, a protective barrier against sudden bursts, are analyzed. A possibility of reducing seam burst hazards during working face mining is substantiated.

REGULATIONS

REFER ALSO TO CITATION(S) 55608, 55730, 56956, 56961

55739 Present coal and energy policy in the European community. Williams, L. (Komm der Eur Gem, Ger). *Glueckauf;* **113**: 311(17 Mar 1977). (In German).

Problems of common energy supply policy, coal and fuel imports, and resources coordination are discussed.

55740 Good prospects for coal in Great Britain. Ezra, D. (Natl Coal Board, London, Engl). *Glueckauf;* **113**: 312-317(17 Mar 1977).

Review of postwar energy market developments is given, and Britain's coal program is evaluated. Prospecting for new deposits is described and investment trends are reviewed.

PETROLEUM

RESERVES

REFER ALSO TO CITATION(S) 55665

55741 Oil and gas geological zoning of the Siberian Platform. Kontorovich, A.E.; Mel'nikov, N.V.; Starosel'tsev, V.S. (Sib Sci Res Inst of Geol, Geophys, and Miner Raw Mater, USSR). *Geol. Nefti Gaza;* No. 2, 6-16(1976). (In Russian).

Relying on a systematization of previous explorations and new data, a new oil and gas geological zoning of the Siberian Platform, carried out according to a unified principle, is presented. Nonuniform distribution of oil and gas reserves over stratigraphic complexes and territory of the Siberian Platform makes it possible to single out two oil and gas-bearing provinces: the Lena-Tunguska and Khatanga-Vilny areas. The main oil and gas beds of the Lena-Tunguska province are concentrated in the Cambrian deposits. The province comprises nine oil and gas fields. The Khatanga-Vilny oil and gas bearing province is related to the marginal Upper Paleozoic and Mezozoic depressions of the Siberian Platform. Oil and gas potential is connected with the Upper Paleozoic and Mezozoic deposits. Three oil and gas-bearing fields have been discovered. 13 refs.

55742 Cyclic character of the processes of oil and gas generation, petroliferous provinces, basins and regions. Maksimov, S.P.; Eremenko, N.A.; Botneva, T.A.; Pankina, R.G. (All-Union Sci Res Geol Inst, USSR). *Geol. Nefti Gaza;* No. 2, 30-43(1976). (In Russian).

A study of the regularities of oil and gas distribution in a number of regions of the USSR and throughout the world shows that processes of oil and gas formation are characterized by a certain

cyclicity. Cycles are grouped in larger megacycles united by a single stage of tectogenesis, during which similar climatic conditions and a specific composition of the organic material existed in the oil and gas generation basin. Development of megacycles and cycles is connected with a certain space, viz. large segments of the earth's crust (megacycles), petroliferous basins, provinces and regions (cycles), within which oil and gas-bearing formations are widespread. Factors determining the development of megacycles and cycles of oil and gas formation are considered and a number of comparative diagrams are presented. 16 refs.

55743 Predicting oil and gas potential from tectonic conditions of distribution of oil and gas fields in west Pre-caucasus. D'yakonov, A.I. (Sci Res Plann Pet Inst, Krasnodar, USSR). *Geol. Nefti Gaza;* No. 12, 8-14(1976). (In Russian).

In the light of up-to-date data on tectonic zonality and development of the region, the regularities of the tectonic distribution of oil and gas are considered. The dependence of the distribution of hydrocarbon accumulations on the rate of sagging of that particular part of the Earth's crust, the time of origin of local uplifts and the rate of their growth during the main phase of oil formation, is substantiated.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 57464, 57477

55744 Rock-fluid relationship studies on the Windfall D-3A reservoir and their application in evaluatiang gas cycling effectiveness. McFadzean, T.B. (Amoco Can Pet Co, Calgary, Alberta). *J. Can. Pet. Technol.;* **16**: No. 1, 55-63(Jan-Mar 1977).

The Windfall D3A reservoir in north-central Alberta is a Devonian Leduc D-3 reef structure containing sour gas, condensate and oil. This paper describes the results of recent studies on rock-fluid relationship for the Windfall reservoir which led to several conclusions regarding the effectiveness of the past 15 years of cycling and the importance of maintaining high voidage replacement ratios. It is postulated that the sweep efficiency of the cycled gas in Windfall is low due to the heterogeneous permeability distribution within the reservoir. It is concluded that liquid recoveries can be further enhanced by altering production-injection flow patterns. 4 refs.

55745 Example of statistical data available for petroleum exploration: the STATSID file. Coustau, H. (Soc Natl des Pet d'Aquitaine, Fr). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 1, 3-21(Jan-Feb 1977). (In French).

The STATSID File is a data bank containing a country-by-country, year-by-year census of the leading petroleum statistics, i.e. how search permits evolve, exploration efforts (geophysics and drilling), reserves and productions. These basic data can be used to compile statistics such as the rate of success, the yield of exploration efforts, geopetroleum properties (richness in hydrocarbons, type of habitat), reservoir-field parameters, as well as statistical references which are of great help in decision making, such as the exploration effort required for making an initial discovery. The main processing programs by which these data can be retrieved from the file are given. 5 refs.

55746 Rapid method for source rock characterization and for determination of their petroleum potential and degree of evolution. Espitalie, J.; Laporte, J.L.; Madec, M.; Marquis, F.; Leplat, P.; Paulet, J.; Boutefeu, A. (Inst Fr du Pet). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 1, 23-42(Jan-Feb 1977). (In French).

Fundamental research on kerogens by different physicochemical analysis methods have led to the development of a method and equipment suited for petroleum exploration. The development of this method is described and, by means of the parameters it determines how it can be applied in the yield of petroleum exploration: exploring different types of source rock and their petroleum potential; characterizing their degree of evolution (oil zone/gas zone). This method is also shown to be particularly suited for estimating the oil field of oil shales and investigating the quality and classification of coal. 24 refs.

55747 Direction of exploration and possibilities of hydrocarbon pool discoveries in the Volyno-Podolian area. Glushko, V.V.; Sandler, Y.M.; Skorduli, V.D.; Khizhnyakov, A.V.; Kotyk, V.A.; Trushkevich, R.T.; Yushkevich, V.I.; Boiko, V.N.; Buderkevich, M.D. (Sci Res Inst of Geol Explor, Ukr SSR). *Geol. Nefti Gaza;* No. 1, 29-33(1977). (In Russian).

Relying on the results of geological and geophysical investigations, the oil and gas-bearing potential of the area in question is evaluated positively. The areas most promising for prospecting work are indicated. They run in a belt from Vladimir Volynsky south through Brody and Buchach towards Chernovtsy.

55748 Data base for analyzing results of oil and gas exploration. Kalinina, V.P. (All-Union Pet Sci Res Inst of Geol Explor, Leningrad, USSR). *Geol. Nefti Gaza;* No. 1, 5-10(1977). (In Russian).

Problems of composition and organization of data files for analyzing results of oil and gas exploration and evaluating its geological and economic efficacy in the Automatic management system--oil exploration subsystem are considered. A block diagram of the data base structure and a model of logical data relations are presented. The block diagram is based on real accounting and report data, sets of which, constructed in a particular way, may be utilized both for analysis and for devising a data bank for a system of management of the oil and gas exploration process.

55749 Calculation of oil and solution and free gas initially in place and their recovery during exploration. Secen, J.; Gazdag, J. (INA-Naftaplin, Zagreb, Yugosl). *Nafta (Zagreb);* **27**: No. 12, 633-646(Dec 1976). (In Serbo-Croatian).

The main properties, which can be useful in estimating the oil and gas reserves during reservoir exploration by the method of least squares and method of averages, are determined. These are (at the initial reservoir conditions): oil formation volume factor, solution gas-oil ratio, and gas formation volume factor, as well as oil, gas and solution gas recovery for the depletion drive reservoirs. To calculate these values, the relationships among pressure, temperature, gas-mixture composition and reservoir depth must be determined. All data presented here are from the oil fields of Croatia, Yugoslavia. 3 refs.

55750 Middle--upper Devonian clastic wedge of the Franklinian geosyncline. Embry, A.; Klovan, J.E. (Br Pet, Calgary, Alberta). *Bull. Can. Pet. Geol.;* **24**: No. 4, 485-639(Dec 1976).

This paper describes the results of a project undertaken to study the Middle-Upper Devonian clastic wedge of the Canadian Arctic Islands. The main objectives were to determine: (1) Regional stratigraphic relationships within the clastic strata; (2) Environments of deposition of the strata; (3) Nature and location of the source area(s); (4) Geological history of the Arctic Archipelago during Middle and Late Devonian time; and (5) Economic potential of the strata. The Devonian strata may have uranium potential. Certain sandstone units are rated as having the highest potential for petroleum accumulations. Maps are included at the end of the paper. Refs.

55751 Geothermal conditions of subsalt rocks of the eastern part of pre-caspian depression and their oil and gas potential. Dal'yan, I.B.; Posadskaya, A.S.; Svetlakova, E.A.; Kuznetsova, L.V.; Sydykov, Zh.S. (NRE, Aktyubinsk, USSR). *Geol. Nefti Gaza;* No. 11, 22-26(1976). (In Russian).

The possibility of preservation of subsalt deposits of hydrocarbons in the liquid phase on the basis of present-day geothermal conditions in subsalt rocks in the Eastern part of the Pre-Caspian depression is considered. An analysis of temperatures in subsalt deposits of this region makes it possible to predict that oil deposits will be found in them at the depths of up to 9 km. 10 refs.

55752 Paleozoic carbonate formations in the south-east of Russian Platform and their oil and gas potential. Kuznetsov, V.G.; Proshlyakov, B.K. (Moscow Inst of Natl Econ, USSR). *Geol. Nefti Gaza;* No. 11, 26-32(1976). (In Russian).

The material on carbonate formations in the South-East of the Russian platform is studied and systematized. It is noted that considerable accumulations of oil and gas are bound up with these formations. The lithological composition, structure, and association of organisms are investigated and paleogeographic conditions of formation of carbonate deposits are established.

55753 Formation of oil and gas pools and technique for their exploration in southern regions of Siberian platform. Antsiferov, A.S. (East Sib NIIGG, USSR). *Geol. Nefti Gaza;* No. 12, 5-8(1976). (In Russian).

Data on the comparatively young age of the Markovo, Yaraktino and other deposits of the southern part of the Siberian platform are presented. An opinion is expressed about several stages in the formation of the pools. The latest took place in the Neogene-Quarternary period owing to the release into the free phase of hydrocarbons dissolved in strata waters. It is suggested that oil and gas exploration should be conducted not only in old structures but also in the younger ones (including the neotectonic ones).

55754 Evaluation of oil and gas potential in Maykopian sedimentary rocks in crimeia, west pre-caucausus and offshore areas of Karkinit Bay and Azov Sea. Terdovidov, A.S.; Chupis, N.E. (Sci Res Inst of Gas Ind, Ukr SSR). *Geol. Nefti Gaza;* No. 12, 15-20(1976).

Relying on hydrogeochemical indices singled out by the authors, oil and gas potential of a number of structures is evaluated favorably. They are situated both on land (the Anastasiyevskaya-Krasnodar anticlinal zone, the northern zone of the tapering off of the Maykopian sands) and offshore (the Obruchev, Elektrorazvedochnaya, and Morskaya structures, etc.). Two zones of hydrocar-

bon accumulations are singled out: the northern, mostly gas-bearing one, and the southern, mostly oil-bearing one. 9 refs. Russian.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 55744, 55780, 55781, 55798, 55800, 57172

55755 (FE—5302-5) **Tertiary oil recovery by CO_2 injection. Quarterly report, October—December 1976.** Conner, W.D. (Columbia Gas Transmission Corp., Charleston, W.Va. (USA)). Jan 1977. Contract EF-76-C-05-5302. 30p. Dep. NTIS $4.00.

In an effort to obtain better mobility control, it has been decided by the Technical Committee to continue to inject the initial slug of CO_2 in stages with alternating slugs of water. The status of each injection well is described. Currently, the injection phase of the project is approximately 76 percent complete. Production data gathered to date indicate that approximately 3481 bbls. of oil have been recovered as a result of CO_2 injection. Tests have indicated that Well No. 4254 produces best by maintaining approximately 40 to 50 psi back pressure. This pressure produces a steadier flow, reduces paraffin accumulation and maintains better reservoir control than allowing the well to surge.

55756 (NP—22197) **Electrofrac's secondary oil recovery systems.** (Electrofrac Corp., Kansas City, Mo. (USA)). [nd]. vp. Corp., Kansas City, MO.

The "Electrofrac Technique" for oil recovery uses thermal energy to increase permeability and partially vaporize the oil in place, thereby driving this more mobile fluid to producing wells. Reduced to the simplest terms, "electrofracing" is a system of electrical oil production methods. The technique will vary from one kind of reservoir to another. In some fields electrical stimulation of oil flow will be exclusively by electrothermal effect. Under some different reservoir conditions, the combustible air/gas mixture is formed in the oil reservoir and electrically "detonated". The spontaneous combustion of this gas generates a temperature increase and also additional pressure in the reservoir. This process is called "electropressurization" and is used cyclically in order to regulate the economical aspects of the electrothermal oil recovery toward the optimum profits. The problem of production well clogging is also solved through this process. The electric energy heats both the oil formation near the oil well and the production tubing for paraffin removal. When oil and gas must be produced from solid petroleum source material, such as oil shale or tar sand, Electrofrac techniques are carried several steps further for recovering the energy by in situ electro-gasification process. In this case, the air or other reactants are injected into the hot, electrically formed carbon zone between wells and the hydrocarbons are converted into the gaseous or liquid products by the in situ electro-gasification technique. The effectiveness of the underground gasification is greatly enhanced by controlling and affecting the chemical reactions by electrical energy.

55757 (USGS-OFR—77-130) **DEROCS: a computer program to simulate offshore oil and natural gas development scenarios and onshore service base requirements.** Marcus, P.A.; Smith, E.T.; Robertson, S.R.; Wong, A.T. (Geological Survey, Reston, Va. (USA)). Mar 1977. 256p. TIC.

The FORTRAN IV (H) computer program, DEROCS, constructs Outer Continental Shelf (OCS) resource development scenarios and quantifies the requirements for and impacts of the operation of the onshore service bases necessary to support offshore oil and gas operations. The acronym DEROCS stands for "Development of Energy Resources of the Outer Continental Shelf." The user may specify the number, timing, and amounts of offshore oil and natural gas finds, onshore service base locations, and multiplier relationships between offshore development activities and onshore land, supply, labor and facility requirements. The program determines schedules of platform installation, development drilling, production from platforms, and well workover, and calculates on a yearly basis the requirements for and impacts of the operation of the onshore service bases demanded by offshore activities. Two examples of program application are presented.

55758 **Deviated conductor driving system.** Horvath, L. (to Hebert and Co., Inc. Gurtler). US Patent 4,027,734. 7 Jun 1977. Filed date 11 Dec 1975. 8p.

A method and technique are claimed for a deviated (non-vertical) emplacement of a conductor casing at a desired curver and orientation in order to facilitate directional drilling of a well in the substratum of an offshore well site. The method provides for the installation of a relatively short, offset portion of the conductor casing at only the bottom of the conductor pipe string and thereby utilizing this offset portion to force the conductor string in a desired direction and orientation by driving or forcing the conductor casing through a substratum in such a manner that the casing will assume the desired curvature and direction as it advances through the substratum. In addition to the offset or dog-leg segment at the bottom, key-way type guide bars can be added in the longitudinal direction to resist undesired rotation of the conductor pipe.

55759 **Method and apparatus for connecting two or more components of an offshore platform.** Guy, A.L. Jr. (to Exxon Production Research Co.). US Patent 4,027,493. 7 Jun 1977. Filed date 15 Apr 1976. 8p.

Method and apparatus for joining two or more substructure components of an offshore platform in the water to form a unitary substructure component or jacket are claimed. An offshore platform to be located in deep water includes a jacket having at least two sections each composed of at least three legs. The legs are hollow and compartmented and provided with means to adjust the buoyancy of each leg. Each section is launched separately and floated in the horizontal position with sufficient buoyancy to maintain at least one leg at or above the water's surface. One of the sections is floated toward a selected shore site until its submerged leg or legs are grounded and the jacket section made negatively buoyant. Another jacket section is floated to the shore site and its legs are aligned with the legs of the already grounded section. The companion legs of each section are then joined to form a unitized jacket. The other jacket section may also be grounded and made negatively buoyant prior to joining the two sections. Support means, such as skids and/or jacks may be used to transform the sea floor at the shore site to a desired, proper grade or slope for joining the jacket sections. The utilized jacket is floated to the deep water location at which the offshore platform is to be installed and the sections are controllably ballasted to position the jacket upright. The jacket is then anchored to the sea floor and the deck of the platform is placed or stabbed onto the anchored jacket.

55760 **Recent new oil sources and their implications for world energy.** *Energy Dig. (London) ;* 6: No. 1, 4-5, 7(Feb 1977).

The actual quantity of recoverable oil in Alaska and the North Sea is small in relation to total world reserves, Prudhoe Bay being two per cent of the world total and the North Sea about four per cent. But the oil is well placed in the sense of being domestic, within major industrial countries enjoying relative political stability. Alaskan and North Sea oil is also of excellent quality, it has a relatively low sulphur content, and individual well productivities are relatively high. The practical problems and costs of obtaining the oil from these fields are reviewed, and the ways in which the imposing natural obstacles have been overcome or adapted to, are described. What the enormous efforts of the oil industry over the past decade have achieved is a reasonable expectation of adequate supplies to meet a steadily increasing demand over about the next 20 years from a wide variety of sources. The author believes that the world over the next 20-25 years will need as much coal, gas, oil and nuclear power as can be produced. Similarly, our efforts to use primary fuel more efficiently, to conserve and to replace non-renewable oil, gas and coal whereever possible by natural sources such as the sun, the waves and the tides, are altogether too half-hearted. Since the first major oil discoveries were made in the North Sea, the world has consumed more than five times the total discovered reserves in the entire North Sea. Five North Seas gone during the period taken to develop just one new North Sea. The industrial world must halt the growth in its oil consumption.

55761 **Advanced drillship for deep water operations.** Bax, J.D. (IHC Gusto). *Energy Dig. (London) ;* 6: No. 1, 10-13(Feb 1977).

Common to a drill ship, barge or semi-submersible is the need for an anchoring or positioning system. If dynamic positioning is chosen--that is stationing by means of thrust and The or similar connections to the seabed--the ship has an advantage over the semi-submersible. A ship can head into wind and waves, thereby reducing its exposed profile and thus the power needed for dynamically maintaining its position. Less volume and less weight also reduce fuel consumption. Decisive for the selection of semi-submersible or of ship is the mission profile. If the design criteria include worldwide drilling for exploration in widely scattered areas, far away from supply bases and in the water depths of continental shelves and slopes, then there is but one answer: a dynamically positioned ship. The basic position measurement system is an acoustic one incorporating at least one seabed beacon and three ship-mounted hydrophones. The deeper the water, the more the acoustic signal from the beacon is attenuated. This acoustic position measurement is perfectly feasible for water depths of 3000 meter and above. The same statement can not be made for the prime back up system: the taut wire. In a dynamic positioning system however, it is a must to have a realiable back-up system for such important measurements as the actual ship's position. Now available but yet unproven in a DP system is the inertial reference unit (IRU) which could for a certain length of time maintain the ship's position without any external information. Another system that is soon to be tested is making use of doppler sonar speed measurement relative to deep water layers. Experiences with the dynamically positioned drilling vessel Pelican since 1972 are reported in some detail. Design considerations for drillships to accomodate wellhead equipment are described.

55762 Description of the waterflooding computation methods for oil fields. Krizmanic, K. *Nafta (Zagreb);* **28**: No. 1, 15-23(Jan 1977). (In Serbo-Croatian).

To determine the increased oil recovery by waterflooding, the calculations must consider fluid flow characteristics, heterogeneity of the oil field, well pattern, as well as fluid and source-rock physical properties. Quality input data and their processing by computer are required. An overview of various waterflooding methods and basic characteristics of the computation is given. 4 refs.

55763 Performance of the Taber South polymer flood. Shaw, R.A.; Stright, D.H. Jr. (Ashland Oil Can Ltd, Calgary, Alberta). *J. Can. Pet. Technol.;* **16**: No. 1, 35-40(Jan-Mar 1977).

A polymer flood was initiated in the Taber South Mannville B Pool in February, 1967. The reservoir was studied with reservoir simulation models in an attempt to identify incremental polymer flood oil recovery (relative to waterflood). Results of a wettability study using restored cores under reservoir conditions are presented. The potential effects of wettability on polymer flood performance are discussed. Some indirect observations on polymer quality are presented to help shed some light on the performance of this major polymer flood. 17 refs.

55764 Rolls-Royce Avon in the Middle East. *Sawyer's Gas Turbine Int.;* **17**: No. 6, 36-37(Nov-Dec 1976).

A Rolls-Royce industrial Avon gas generator No. 37251, operated by Petroleum Development (Oman) Limited at the Fahud-Natil oil field, has achieved 37,960 hours since its last overhaul, bringing the total running time to 48,324 hours.

55765 Stability of the replacement of a non-Newtonian fluid layer in a porous medium. Rubezhanskii, V.I. *Fluid Dyn. (USSR) (Engl. Transl.);* **11**: No. 2, 326-330(Mar-Apr 1976).

When petroleum is extracted from strata by replacing it with other fluids, the question arises of the stability of the interface. Uniformity in the injection horizons is in practice achieved by such methods as using polymer additives to thicken the replacing fluid or introducing a intermediate layer with non-Newtonian properties between the replacing fluid and the fluid being replaced. In this article the stability of the interface of non-Newtonian fluids being filtered exponentially is investigated in a linear formulation. The condition governing the stability of the interface of two non-Newtonian fluids is found and the influence of the thickness of the intermediate layer on the stability is also demonstrated. The presence of the layer is found to be essential for certain parameters of fluids moving in a porous medium if the replacement is to be stable.

55766 Determination of the front of propagation of the permafrost thawing zone around producing wells. Kerimov, Z.G.; Yagubov, N.I.; Abdullaev, T.B. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 6, 47-50(1976). (In Russian).

Analytical expressions are obtained for temperature changes in the rock and the propagation of the thawing wave front. Results of theoretical calculations show a good agreement with operational data (the error rate amounts to some 10%).

55767 Thermal insulating fluid. Howland, J.W.; Rosso, J.C. (to Gulf Oil Corp.). US Patent 3,642,624. 15 Feb 1972. Filed date 12 Dec 1968. 6p.

This patent pertains to a thermal insulating fluid for use in the tubing-casing annulus of a steam injection well. The fluid contains as a major ingredient a heavy mineral oil, preferably having an API gravity less than 30°. The fluid contains ingredients which will form a water-insoluble soap when the fluid is heated. The viscosity and insulation properties of the fluid are increased by the incorporation of 2 to 6 percent water, a bentonite-organic base compound, and finely divided asbestos fibers.

PROCESSING

REFER ALSO TO CITATION(S) 55778, 57263

55768 Steam treatment of sulfur-containing heavy crude oil or oil residue with a combination catalyst comprising a hydrogenation-desulfurization catalyst and an overbased jet fuel containing an alkaline earth or alkali metal alkyl phenol complex. Pitchford, A.C.; de Vault, A.N. (to Phillips Petroleum Co.). US Patent 3,649,527. 14 Mar 1972. Filed date 23 Mar 1970. 6p.

An overbased jet fuel containing dispersed alkaline earth metal carbonate, e.g., calcium carbonate, and an alkaline earth or alkali metal alkyl phenol complex, e.g., calcium octyl phenol complex, is combined with an oil-soluble hydrogenation and desulfurization catalyst, e.g., nickel stearate, to provide a catalyst for a high-temperature, elevated-pressure steam treatment of a heavy crude oil or oil residue to generate in-situ hydrogen, thus reducing the specific gravity and the sulfur content of the crude and minimizing coke formation.

55769 Recovery of flare gases: a technical process for economical use of flare gases. Schwarz, F.; Bauer, E. (Oesterr Mineraloelverwalt, Austria). *Erdoel-Erdgas Z.;* **93**: No. 3, 91-92(Mar 1977). (In German).

Recovery of flare gases is not only a question of meeting the safety requirements in oil refineries and petrochemical plants: Recently, the need for energy conservation and environmental protection has been gaining increased importance. The authors show that by introducing a compressor into the flare gas system and employing modern control engineering and instrumentation, it is possible to obtain a highly economical solution to the recovery of flare gases without the use of a gasometer. 4 refs.

55770 Possibility of selecting the most economical pour point depressant from the user's standpoint. Bencic, B.; Delfin, B.; Domes, J.; Singer, Z. (INA-Naftaplin, Zagreb, Yugosl). *Nafta (Zagreb);* **27**: No. 12, 653-662(Dec 1976). (In Serbo-Croatian).

The Beneanci field is the first oil field in Croatia, Yugoslavia, to produce a crude oil with a pour point of +18°C. Various possibilities were studied, and a decision was reached on the use of pour-point depressant that would ensure trouble-free transport of crude through petroleum pipelines. Economic reasons, coupled with a gradual tripling of production, prompted INA-Naftaplin's experts to try various additives, taking into consideration not only their price but also transportation expenses and the cost of their preparation for use. Passing from plastic additives to solid and liquid ones, total cost of oil treatment kept decreasing, and the pour point was always maintained below +5°C. 1 ref.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 55587, 55787, 55788, 55988, 55989, 55990

55771 Process for the preparation of low pour point lubricating oils. MacDonald, J.M.; Kartzmark, R. (to Exxon Research and Engineering Co.). US Patent 4,028,224. 7 Jun 1977. Filed date 17 Dec 1975. 12p.

Process is claimed for the preparation of low pour point lubricating oils comprising: (1) Vacuum distilling a heavy naphthenic crude oil feedstock containing from about 2 to 10 weight percent of sulfur based on the weight of the feedstock, said feedstock exhibiting a specific gravity ranging from about 5 to 20° API to obtain at least one distillate cut exhibiting a boiling range of from about 500 to 1000°F and a specific gravity ranging from about 10 to 25° API. (2) Hydrocracking said distillate cut in at least one hydrocracking zone in contact with a hydrocracking catalyst at a temperature from about 650 to 850°F, a hydrogen partial pressure of about 500 to 5000 psig and a space velocity of from about 0.1 to 2.0 V/V/Hr. (3) Removing the low boiling light ends from the hydrocrackate. (4) Recovering a low pour point lubricating oil.

55772 Molecular-chain buildup in the FT synthesis. Schulz, H. (Univ Karlsruhe, Ger). *Erdoel Kohle, Erdgas, Petrochem. Brennst.-Chem.;* **30**: No. 3, 123-131(Mar 1977). (In German with English abstract).

This article deals with the reaction steps involved in the Fischer-Tropsch (FT) Synthesis whose development started 50 years ago and is still being pursued vigorously. Discussion of this complicated and versatile synthesis focuses on the steps of a molecular chain buildup reaction, in which the chains from CH_2 groups are formed from carbon monoxide and hydrogen to produce a number of products, e.g., paraffins, olefins or alcohols. Selectivity of the synthesis products is also discussed. 31 refs.

55773 Contribution to the chemistry of oligo-olefins. Krentsel, B.A.; Mouchina, E.A.; Borissova, N.A. (Inst de Synth Petrochim, Acad des Sci, USSR). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 1, 59-71(Jan-Feb 1977). (In French).

Analyses of data from the literature and from experimental findings concerning the oligomerization of olefins in the presence of transition-metal complexes are presented. The influence of different Lewis acids and phosphates on the catalytic activity and the selectivity of olefin dimerization catalysts is examined. A possible mechanism for the oligomerization of olefins by pi-allylic complexes of nickel is proposed on the basis of experimental data obtained. 51 refs.

55774 Study of chemical behavior of dispersant additives on metal surfaces: reaction of amide functions on aluminum oxide. Nechtschein, J.; Sillion, B. (Inst Fr du Pet). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 1, 103-112(Jan-Feb 1977). (In French).

Analysis of the chemical reactions that appear between the amide functions entering into the composition of numerous dispersant formulas for fuels and lubricants and the surface of aluminum is

presented. The reactions of amides on an aluminum surface is shown to take place in two stages. The first stage, or chemisorption stage, involves Lewis sites and the OH groups next to the aluminum oxide so as to fix the amide function by the carbonyl group (Lewis acid-basic bonds) and by nitrogen (hydrogen bond). The second stage, or hydrolysis stage, leads to the formation of a surface carboxylate and an amine. 19 refs.

55775 Role of antiwear additives for lube oils in a friction test simulating ring-liner contact. Martin, J.M.; Chappuis, J.; Georges, J.M. (Ec Cent de Lyon, Fr). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 1, 113-130(Jan-Feb 1977). (In French).

The tribological conditions in the test used are similar to those existing in the ring-liner area of explosion engines. Various commercial oils are tested along with pure additives. Since temperature is chosen as a variable parameter, it is possible to determine a temperature range for each lubricant, corresponding to the maximum efficiency zone for the antiwear additive it contained. The temperature corresponding to the lower limit of this range is linked to the chemical nature of the additive. Likewise, when a temperature gradient exists between two rubbing parts, a vertical pulsation phenomenon of the drop of oil in the contact area occurs in the maximum efficiency zone of the lubricant. Interpretation elements explaining these two phenomena are proposed and lead to linking the antiwear efficiency of an additive to its adsorption properties on the surface of rubbing parts. 13 refs.

55776 Use of petroleum residues as binder in briquetting of coal. Rutkowski, M.; Wieckowska, J. (Wroclaw Politech, Pol). *Przem. Chem.;* **55**: No. 12, 585-586(Dec 1976). (In Polish).

Residues from vacuum distillation in Polish refineries have been used for briquetting coal smalls and slurries. They have been shown to be good binders if the manner of preparing briquetting mixture is different from those used previously. The resulting briquettes conform to all requirements of the Polish standards. By applying suitable coal mixtures, briquettes of increased fire resistance can be obtained. 4 refs.

55777 Correlation between the content of n-paraffins and some basic properties of diesel fuels. Petrovic, K.; Stojanovic, L.; Vitorovic, D. (Naftagas , Novi Sad, Yugosl). *Nafta (Zagreb);* **27**: No. 12, 647-651(Dec 1976). (In Serbo-Croatian).

The relationship between the total content of higher n-paraffins (i.e. the three last members of the n-paraffin series) and the low-temperature properties of middle distillates were studied. It was found that under certain conditions this relationship can be used for a quick and efficient prediction of the cold filter plugging point and the cloud point. 13 refs.

55778 Structural change in feedstocks supply for the petrochemicals industry. Walley, K.H. (Shell Int Chem Maatsch, The Hague, Neth). *Chem. Ind. (London);* No. 22, 982-985(20 Nov 1976).

The European petrochemicals industry has grown up on the basis of an assured supply of cheap naphtha, a very comfortable position that lasted for 25 years. The oil industry was able to find and produce crude oil in ever-increasing amounts and to finance the necessary tankers and refineries well in advance of the growth in demand--a secure background indeed for the infant petrochemicals industry. By the early 1970s a new factor merged: the installations being planned and built for base chemicals were of such a size that the local demand for naphtha was becoming really significant in relation to the output from even large refineries. The discussion of the subject is presented under headings--strong underlying trend; feedstock availability, gas oil and fuel components; understanding and anticipation.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 56923, 56938, 57408

55779 (MERC/RI—77/1) Plugging techniques that should allow mining through wells. Final report. (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). Jun 1977. 106p. Dep. NTIS, PC A06/MF A01.

Research carried out since 1971 on plugging oil wells penetrating minable coalseams has allowed for safe underground mining through wells and recovering heretofore unrecoverable coal reserves. Work conducted under this research has consisted of plugging 27 wells and mining through 7 of them. This report covers the day-to-day record of plugging 23 of these wells and mining through 6 of them.

55780 Safety aspects in offshore design. Anon. *North. Offshore;* **6**: No. 2, 35-36, 38(Feb 1977).

The production platforms in the North Sea, just like other offshore structures, cannot rely on quick assistance from shore in an emergency. Therefore, these platforms must be self-reliant and able to handle all situations that might pose a threat to personnel, facility and environment. Safety aspects in the design of production platforms are discussed and design guidelines to be followed in Norwegian waters are presented.

55781 Safety conditions during testing of oil and gas bearing formations containing hydrogen sulfide. Szostak, L. (Akad Gorn-Hutn, Pol). *Tech. Poszukiwan Geol;* **15**: No. 5, 6-8(1976). (In Polish).

Hydrogen sulphide sometimes can escape from the borehole during testing. This gas is very dangerous because of its toxic action on human organisms. Those working on the drilling site during such borehole testing should know the basic precautionary measures, methods of H_2S detecting in the air and determining its concentration, symptoms of poisoning and principles of first aid treatment. 1 ref.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 55603, 55795, 56950, 56973

55782 (NTISUB/B—125-76/011) Petroleum market shares. Report on sales of retail gasoline. Monthly report. (Federal Energy Administration, Washington, D.C. (USA)). Nov 1976. 8p. (FEA/B—77/078). copy also available on subscription, North American Continent price $25.00/year; all others write for quote.

See also NTISUB/B—125-76/010.

This is one in a monthly series of reports that monitors changes in the aggregate market shares of motor gasoline retailers. It is based on a continuing survey of gasoline service stations conducted by the Bureau of the Census. The survey obtains data on the number of gallons sold by approximately 10,000 sample stations each month. This information is used to develop universe estimates of market shares as required by Section 4(c)(2)(A) of the Emergency Petroleum Allocation Act of 1973 for nonbranded independent marketers, branded independent marketers, and other persons engaged in the marketing or distribution of refined petroleum products.

55783 (PB—263966) Petroleum market shares: report on sales of refined petroleum products, October 1976. (Federal Energy Administration, Washington, D.C. (USA)). Mar 1977. 23p. (FEA/B—77/037). NTIS PC A02/MF A01.

This is one in a continuing series of reports of monitored monthly changes in the refiner sales distribution and the retail market shares of selected refined petroleum products. This report covers sales for October 1976. Estimates of volume sales and market shares are based on monthly sample surveys of refiners and independent marketers.

55784 (PB—264142) Monthly petroleum product price report. Byers, L.; Connor, B.; Davis, W.; Whatley, A.; Gillespie, W. (Federal Energy Administration, Washington, D.C. (USA)). Nov 1976. 19p. (FEA/B—77/065). NTIS PC A02/MF A01.

This report provides national weighted average prices of petroleum products on a monthly basis at different levels of the marketing chain. In addition to recent price data, some historic data are included to indicate trends. Average prices are derived from a survey of refiners, large resellers/retailers, and gas plant operators; and from a survey of gasoline service stations and truckstop operators.

55785 (PB—264143) Petroleum market shares. Report on sales of refined petroleum products. Monthly report. (Federal Energy Administration, Washington, D.C. (USA)). Nov 1976. 23p. (FEA/B—77/080). NTIS PC A02/MF A01.

This is one in a continuing series of reports of monitored monthly changes in the refiner sales distribution and the retail market shares of selected refined petroleum products. This report covers sales for November 1976. Estimates of volume sales and market shares are based on monthly sample surveys of refiners and independent marketers.

55786 (PB—264460) Monthly petroleum product price report. Byers, L.; Connor, B.; Davis, W.; Whatley, A.; Gillespie, W. (Federal Energy Administration, Washington, D.C. (USA)). Dec 1976. 20p. (FEA/B—77/098). NTIS PC A02/MF A01.

This report provides national weighted average prices of petroleum products on a monthly basis at different levels of the marketing chain. In addition to recent price data, some historic data are included to indicate trends. Pricing data in this publication are collected from two separate surveys. Average prices are derived from a survey of refiners, large resellers/retailers, and gas plant operators and from a survey of gasoline service stations and truckstop operators.

55787 Changes in the petrol retailing movement. Atkinson, G. (Mot Agents Assoc). *Pet. Rev.;* **31**: No. 363, 7-9, 11(Mar 1977).

Today, small retailers are struggling against new, highly specialized, self-service outlets. The background of present marketing conditions is summarized and suggestions for relieving existing problems are made. Retailers will have to learn to negotiate with suppliers and to cost their businesses properly. They must seek discounts rather than deferred rebates and question the stress on high gallonage as the profit key. Suppliers, for their part, must accept that retailers are customers, and sales must be earned.

55788 National outlets survey for the year-end 1976. *Pet. Rev.;* **31**: No. 363, 15, 17-21(Mar 1977).

Increases in the price and gallon usage of gasoline since 1900 are briefly summarized. A table of suppliers of petrol to the United Kingdom retail market is provided. The table includes brand name, number of retail outlets, self-service stations, company-owned stations, company, and areas of operation for thirty-four suppliers.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 55769, 55776, 55992

55789 Oil conservation and reclamation. Majer, D.J. (APV Bowser Filtration Ltd., Croydon, Eng.). *Chem. Eng. (London);* No. 315, 757-759, 764(1976).

Oil conservation is discussed from the standpoint of conditioning and maintenance of lubricating properties and additive effectiveness to prolong the oil's useability as long as possible. The factors causing deterioration of oil are discussed. A discussion of methods of oil reclamation is accompanied by diagrams of the equipment. (DDA)

55790 Method of rerefining oil with recovery of useful organic additives. Forsberg, J.W. (to The Lubrizol Corp.). US Patent 4,028,226. 7 Jun 1977. Filed date 12 Nov 1975. 4p.

Used oil is rerefined by diluting it with a water-soluble polar diluent and removing insoluble impurities from the resulting solution, adding water to produce a two-phase system, separating the organic phase and removing the polar diluent therefrom. By this method, it is possible to recover oil which still contains viscosity modifying additives and the like. If desired, the rerefined oil can be subjected to further treatment such as hydrogenation.

55791 Lowering of pollutant content in emissions from fuel combustion in boilers of middle capacity. Baumbach, G. (Univ Stuttgart, Ger). *Dechema Monogr.;* **80**: No. 1639-1669, 437-446(1976). (In German).

Various pollutants are expected to be found in the flue gases resulting from industrial combustion processes. In order to investigate the possibility of reducing the emissions, accurate methods of analysis of the pollutants are necessary. A reliable experimental set-up for this purpose is described here. Analyses were made on the flue gases of a heavy oil fired boiler running under various operating conditions. The maximum fuel consumption of the boiler was 5000 kg oil/hour. From the results of these analyses it was shown that possibilities exist to reduce the pollutant content of the flue gas. Of special importance was the turbulence in the combustion chamber and the correct volume of air for combustion. Increased emission content of the flue gas was observed upon ignition and cut-out of the burners. Possibilities for the reduction of these emissions were suggested. 4 refs.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 57448

55792 (PB—264870) Oil spill and oil pollution reports, May 1976—July 1976. Quarterly report. Melvin, P.; Ehrenspeck, H. (California Univ., Santa Barbara (USA). Marine Science Inst.). Oct 1976. Contract EPA-R-803992. 357p. NTIS PC A16/MF A01.

See also PB—259932.

The May 1976 - July 1976 Oil Spill and Oil Pollution Report is the eighth quarterly compilation of oil spill events and oil pollution report summaries. Presented in the report are: (a) summaries of oil spill events; (b) summaries and bibliographic literature citations; (c) summaries of current research projects; and (d) patent summaries. This report is submitted in partial fulfillment of EPA Grant No. R-803992 by the Marine Science Institute, University of California, Santa Barbara, under the sponsorship of the Environmental Protection Agency.

55793 Continuous spilling of hot oil on ice. Siu, S.K.; Phillips, C.R.; Chen, E.C. (Univ of Toronto, Ont). *J. Can. Pet. Technol.;* **16**: No. 1, 31-34(Jan-Mar 1977).

The continuous spilling of hot crude oil onto an ice surface was investigated with oil temperature, ice temperature and spilling rate as parameters. Crude oil from commercial production at Normal Wells, Northwest Territories, Canada, was used. The conclusions reached and the physical model developed provide a framework for considering the effects of changes in spill rate, oil temperature, ice temperature and time on the area of a hot oil spill from a continuous source such as a pipeline leak. 7 refs.

55794 Seismicity and faulting attributable to fluid extraction. Yerkes, R.F.; Castle, R.O. (US Geol Surv, Menlo Park, Calif). *Eng. Geol. (Amsterdam);* **10**: No. 2-4, 151-167(Dec 1976).

Two unequivocable examples of seismicity and faulting associated with fluid extraction in the United States are: The Goose Creek, Texas oil field event of 1925 (involving surface rupture); and Wilmington, California oil field events (involving subsurface rupture) of 1947, 1949, 1951, (2), 1955, and 1961. Six additional cases of intensity I-VII earthquakes (M$less than equivalent to$4.6) without reported faulting may be attributable to shallow production from other large oil and gas fields. In addition to these examples are thirteen cases of apparently a seismic surface rupture associated with production from California and Texas oil fields. Small earthquakes in the Eloy-Picacho area of Arizona may be attributable to withdrawal of groundwater, but their relation to widespread fissuring is enigmatic. The clearest example of extraction-induced seismicity outside of North America is the 1951 series of earthquakes associated with gas production from the Po River delta near Caviga, Italy. Faulting and seismicity associated with fluid extraction are attributed to differential compaction at depth caused by reduction of reservoir fluid pressure and attendant increase in effective stress. Surface and subsurface measurements and theoretical and model studies show that differential compaction leads not only to differential subsidence and centripetally-directed horizontal displacements, but to changes in both vertical- and horizontal-strain regimes. Study of well-documented examples indicates that the occurrence and nature of faulting and seismicity associated with compaction are functions chiefly of: (a) the pre-exploitation strain regime, and (2) the magnitude of contractional horizontal strain centered over the compacting materials relative to that of the surrounding annulus of extensional horizontal strain. The examples cited include natural systems strained only by extraction of fluids, as well as some subsequently subjected to injection. 23 refs.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 56951, 56958

55795 Oil in Indonesia. Grenon, M. *Rev. Energ.;* **27**: No. 289, 601-607(Dec 1976). (In French).

Indonesia, a member of OPEP since 1962, is one of the oldest oil producing countries in the world, and its potential and development remain high. Indonesia was the cradle of the Royal Dutch Company, and initiated, about ten years ago, production sharing agreements. These agreements were dangerously shaken in 1976 in an effort to fill gaps created by Indonesia's too ambitious national company, the Pertamina. The fifth country in the world for its population (130-million people), benefiting from agricultural surpluses and holding rich mineral resources other than oil and gas, Indonesia could play an increasingly bigger role in Southeast Asia and in the Pacific.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 55760, 55770, 55818, 57172

55796 Planning and laying of Cormorant pipeline. *Pet. Rev.;* **31**: No. 362, 20-22(Feb 1977).

Following the discovery of a number of offshore oilfields in the North-East Shetland Basin, approximately 100 miles offhore and in around 500 feet of water, the oil industry was faced with the problem of transporting oil to shore. A decision was made to connect some of the fields, Shell/Esso's Brent, Cormorant and Dunlin; Signal's Thistle and Amoco's Hutton to a single line (operated by Shell) from the Cormorant field to the Shetlands. From the landfall on mainland on overland line will carry the crude oil to the projected tanker terminal at Sullom Voe for shipment to refineries. Details are provided of the methods used to determine a sea-bed route and techniques employed in laying the pipeline, including track plotting, seismic profiling, observations by Vickers' Pisces III and laybarge operations.

55797 Cathodic protection of pipes and pipelines offshore. von Baeckmann, W. (Pipeline Eng, Essen, Ger). *Erdoel-Erdgas Z.;* **93**: No. 1, 34-38(Jan 1977). (In German).

The protection from corrosion caused by seawater is the oldest application of cathodic protection. Originally, it was applied

to steel ships and port facilities. On the other hand, the construction and protection of submarine pipelines is a relatively young technique. Cathodic protection has, however, for some decades proved to be also effective with these pipelines, especially when galvanic anodes are used. A general outline is given of the methods and applications of the cathodic protection of structures in seawater by galvanic anodes and impressed current systems. 10 refs.

55798 Computing methods for designing cathodic protection systems for elongate structures. Roche, M. (Inst Fr du Pet). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 1, 43-57(Jan-Feb 1977). (In French with English abstract).

Structures used by the hydrocarbon industry are, in most cases, subjected to a cathodic protection system consisting of sacrificial anodes or an impressed current. Designs of such systems must be based on an analysis if variations in the potential and intensity along the structure as the result of the ohm drop. The conventional computing method commonly solves cases of elongate structures with a constant diameter, running through ground whose resistivity is considered to be constant over the entire length. When the make-up of the structure varies, as is the case for borehole casings, or when it goes through several types of formations, the problem gets more complicated. A general method for quickly dealing with any problem of this type, with no limit to the number of lengths involved and which makes use of reflection factor and equivalent resistance concepts is proposed. 11 refs.

55799 North Sea offshore loading, what is the problem. Nybo, R. (Aker Eng). *North. Offshore;* 6: No. 1, 6, 9-10, 17(Jan 1977).

Ths article discusses a number of factors which affect offshore loading operations and assesses offshore loading as a principle. Offshore loading systems incorporating single point mooring buoys (SPM) are also discussed, and the so-called AKER SLT (Aker Offshore Storage and Loading Terminal) is described. Offshore loading systems, either planned or currently in operation in the North Sea's oil fields, now total ten. 4 refs.

55800 Articulated loading platform (ALP). Larabi, M.; Syljeset, J.E. (Equip Mec et Hydraul, Paris, Fr). *North. Offshore;* 6: No. 1, 15-17(Jan 1977).

A summary is presented of the design, model tests and installation of the so-called articulated loading platform (ALP) which has been in use for some time on Mobil's Beryl oil field, and its larger version which is to be used during the initial phase on the Stratfjord Field on the Norwegian continental shelf. These structures show that offshore oil fields can be exploited by conventional equipment installed on fixed platforms with loading and flaring through articulated columns.

PROPERTIES

REFER ALSO TO CITATION(S) 55770, 55773, 55774, 55793, 57206

55801 Application of gel permeation chromatography to the examination of crude oil. Adler, N.; Budinscak, V. *Nafta (Zagreb);* **28**: No. 1, 27-32(Jan 1977). (In Serbo-Croatian).

Domestic and imported crude oils were investigated by gel-permeation chromatography. Polystyrene gel was used as adsorbent. The purpose of this research was to use the technique of gel-permeation chromatography as a finger print method. Authors tried to identify the following crude oils: Iraqi-light, Libyan-heavy, Moslavina-mixed, Zutica and Benicanci by comparing the gel-permeation obtained chromatograms with the standardized chromatograms of more than 40 different crude oils, and to establish the type to which they belonged. Three samples, i.e. Iraqi-light, Libyan-heavy and domestic crude oil Benicanci gave chromatograms which could be incorporated in the standard oil groups. Two crudes were found unsuitable or incorporation in any of the standard oil groups. 22 refs.

55802 Classification of hydrocarbon pools. Trebin, G.F. (All-Union Sci Res Inst, USSR). *Geol. Nefti Gaza;* No. 12, 27-30(1976). (In Russian).

A single classification of hydrocarbon pools is proposed. As the criterion of separation, the quantitative physico-chemical characteristic according to such parameters as the mean molecular weight or hydrocarbon density in stratal conditions is recommended. 10 refs.

STORAGE

55803 Technical innovations in solution mining and their application in the federal Etzel cavern project. Gomm, H.; Hieblinger, J.; Kuehn, G. (Kavernen Bau- und Betriebs, Hannover, Ger). *Erdoel-Erdgas Z.;* **93**: No. 3, 83-90(Mar 1977). (In German with English abstract).

After briefly examining the planning criteria used, the authors described the operational experience gained in solution mining for the Etzel crude oil underground storage project. New solution mining concepts were developed and applied to create 15, 000 cu m. of cavity volume per day. Also, a numerical, three-dimensional simulation model was employed to help plan and put into practice these new concepts. A computer program was likewise used to graphically present the oil-filled cavern areas and verify the stability requirements having very close tolerances. 4 refs.

COMBUSTION

REFER ALSO TO CITATION(S) 55723, 55724, 55980

55804 Combustion of carbon. Effect of sulfur dioxide. Yang, R.T.; Steinberg, M. (Brookhaven National Lab., Upton, NY). *J. Phys. Chem.;* **81**: No. 11, 1117-1118(2 Jun 1977).

Although sulfur dioxide is generated in most combustion processes involving carbonaceous fuels, not much attention has been paid to its effect on combustion. However, it has been found that, below 500°C, SO_2 retards the oxidation reaction of carbon by O_2; and a sulfoxy species was found on the carbon surface which was held responsible for the retardation. In this report, the observation of a prominent transient effect caused by SO_2 at higher temperatures is presented.

55805 Investigation of the effect of nitrogen-containing fuel additives on the formation of nitrogen oxides. Krutiev, V.A.; Gorbanenko, A.D. (Cent Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 10, 72-75(Oct 1976). (In Russian).

The formation of nitrogen oxides when burning isopropyl alcohol with addition of different nitrogen-containing substances soluble in fuel is investigated depending on the quantity of nitrogen introduced into the fuel with additives, along the length of the combustion chamber of the experimental setup or under the conditions of two-stage combustion. It is shown that, with increased content of nitrogen in fuel, the maximum of NO/sub x/ is shifted towards large air excess ratios.

NATURAL GAS

RESERVES

REFER ALSO TO CITATION(S) 55665, 55742

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 55742, 55744, 55748, 55749, 55751, 55754, 57477

55806 Study to improve downhole equipment for high-pressure gas wells. Hofbauer, K.; Sandkuehler, H.; Simons, D. (Brigitta und Elwerath Betriebsfuehrungs-Ges, Hannover, Ger). *Erdoel-Erdgas Z.;* 93: No. 2, 58-66(Feb 1977). (In German).

After examining conventional gas well completions which show instances of major corrosion (especially in sour gas environments), the authors discuss various types and possibilities of completion, which can increase equipment lifetime and reduce workover costs. Suitable completion design and proper material selection are equally important when coping with the acid components of the gas and unwanted heterogeneous additions. Initial experience with specialty steels is reported. In this context, possible subsurface safety measures are also discussed. 3 refs.

55807 Directions and tasks of oil exploration in the southern part of Timan-Pechora province for 1976-1980. Borisov, A.V.; Leshchenko, V.E.; Sheremeta, O.O. (Pechora Sci Res Plann Pet Inst, USSR). *Geol. Nefti Gaza;* No. 12, 1-4(1976). (In Russian).

In 1971-1972 the Vuktyl gas condensate deposit, one of the largest in the USSR, was developed. In 1973-1975, the Usa and Vozeya deposits were put into operation. An evaluation of the reserves of the southern part of the Timan-Pechora province is given. Exploration of the western part of the Upper Pechora depression of the Pre-Uralian trough and of the Izhma-Pechora depression in the coming Five-Year Plan period is urged.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 55757, 55759, 55815

55808 Natural gas: feedstock for ethylene plants. Frank, H. (Linde, Muenchen, Ger). *Erdoel-Erdgas Z.;* **93**: No. 3, 100-105(Mar 1977). (In German).

Ethane and LPG have become competitive feedstocks for ethylene plants in Europe, where naphtha until now was an almost exclusive feedstock. This new situation is due to a sharp increase in naphtha prices and the discovery of oil and gas fields in the North Sea. The differences between an ethylene plant using ethane and natural gas as a feedstock and that using naphtha are discussed with regard to the processing sequence and economical viability. To reduce operating and investment costs, the integration of an ethane producing plant into an ethylene plant is recommended. 2 refs.

55809 Catalytical removal of nitrogen oxide exemplified by a large plant. Berndt, M.; Ksinsik, D.; Duerrwaechter, E. (DODUCO, Pforzheim, Ger). *Dechema Monogr.;* **80**: No. 1639-1669, 545-553(1976). (In German).

Conditioning natural gas by partial combustion produces nitrogen monoxide. Due to its reaction with unsaturated hydrocarbons and the consequent resinification risk this has to be reduced to a residual concentration of less than 2 ppm by catalytic reduction with carbon monoxide. The description of the process and the catalyst used is followed by an explanation of the basic principles of scale. The paper describes the laboratory trials and initial experience with the full-scale industrial plant.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 55808

55810 Small ammonia plants: prospects for natural-gas utilization in developing countries. Backhaus, H.; Papmahl, F. (LGA Gas and Mar Consult, Remagen-Rolandseck, Ger). *Erdoel-Erdgas Z.;* **93**: No. 3, 93-99(Mar 1977). (In German).

The authors examine the potential of small ammonia plants--delivered by industrialized countries on a turnkey basis and erected on floating structures--for improving fertilizer supplies in developing countries. Compared with large, locally built ammonia complexes, small barge-mounted plants offer the advantages of short delivery and greater adaptability to the domestic ammonia market and its growth. In addition, smaller plants can produce surplus ammonia for exports, thus providing foreign-exchange money to finance the necessary investment expenditure.

55811 Targeting in pipe networks of gas plants. Hermann, W. (Hamburg Gaswerke, Ger). *Gas, Wasser, Waerme;* **30**: No. 12, 363-369(Dec 1976). (In German).

Organization, planning, construction, operation, safety, and commercial tasks are commented on, and complete chart is laid out.

55812 Peak-shaving with Groningen natural gas. Mueller, K. *Linde Rep. Sci. Technol.;* No. 23, 31-35(1976).

Groningen natural gas has a relatively high N_2 content and consequently low heating value. The liquefied product requires special process-engineering methods if the combustion quality of the revaporized natural gas is to attain the same values as that of the original pipeline gas. The paper discusses a solution to this problem and explains the solution with reference to two plant concepts, that of Nederlandse Gasunie and Belgian Distrigaz. 2 refs.

55813 Natural-gas liquefaction by an expansion-turbine mixture cycle. Mueller, K.; Foerg, W. *Linde Rep. Sci. Technol.;* No. 23, 36-41(1976).

Where it is required to liquefy small amounts of natural gas for peak-shaving purposes, a nitrogen-expansion-turbine cycle is the method of choice because of its simplicity. Its disadvantage is the relatively high amount of power required, as compared with other cycle systems. The specific power requirements of a turbine cycle of this kind may be decreased by using a cycle mixture consisting of nitrogen and methane. The method is applied at the Intermountain Gas Co. plant in Boise, Idaho.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 56923

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 55991, 56973

55814 (CONF-770360—1) Status of world trade in liquefied natural gas. Anderson, P.J.; Daniels, E.J. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. 20p. of Gas Technology, Chicago, IL.

From Ports '77 specialty conference of the American Society of Civil Engineers; Long Beach, California, USA (9 Mar 1977).

If all of the announced LNG projects were implemented, the 1985 world LNG trade (including Alaska-U.S. projects) would exceed 25 billion cu ft/day. Approximately 5 billion cu ft/day could be imported by Japan; 7 billion cu ft/day by Western Europe, and almost 15 billion cu ft/day, or 55% of the total, by the United States. The quantities of foreign LNG imported into the United States would total 11.745 billion cu ft/day. LNG delivered from Alaska to the United States would increase this total to 14.954 billion cu ft/day.

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 55794, 57459

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 55756

55815 Recovery of retrograde condensed liquids by revaporization during dry gas injection. Sigmund, P.M.; Cameron, A.M. (Pet Recovery Inst, Calgary, Alberta). *J. Can. Pet. Technol.;* **16**: No. 1, 64-77(1977).

Laboratory experiments were conducted to determine the rates of revaporization of the immobile liquid that was deposited in various porous media as a result of retrograde condensation during pressure depletion of methane n-butane mixtures. The influence of particle size, initial liquid saturation, dry gas injection rate and immobile water saturation on the revaporization process was studied by measuring effluent concentration profiles as a function of volume of methane injected. The revaporization rate was estimated by matching the solution of a mathematical model, in which mass transfer is expressed by a first-order rate expression to the experimental effluent concentration data. 32 refs.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 55703, 56951, 56958, 56974

55816 Business systems for hydrocarbon resources: their credibility in retrospect and in prospect. Mackenzie, W.D.C. (W.D.C. Mackenzie Consult Ltd, Calgary, Alberta). *J. Can. Pet. Technol.;* **15**: No. 1, 37-40(1976).

The author discusses the business system used in the management of exploration and production of hydrocarbons in Canada, which is believed to be based on four cornerstones : the risk-reward relationship; the percentage royalty oil and gas lease; the competition for exploration position; and a public communications strategy. Possible changes in the oil industry's present business system are recommended.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 55797, 56974

55817 (CONF-770577—1) Add-on sectionalizing valves for medium-pressure systems. Long, G.M. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. 24p. of Gas Technology, Chicago, IL.

From American Gas Association Distribution conference; New Orleans, Louisiana, USA (2 May 1977).

Demonstration models of two add-on valve devices are described with illustrations showing installation methods. As designed and built at the Institute of Gas Technology, Chicago, these valve devices can be cut into existing medium-pressure gas (or other fluid) distribution systems without the use of stoppers or interruption of flow. These devices should thereby reduce costs of sectionalizing existing systems as outlined in 192.181 Federal Standard.

55818 (NP—22364) IGT experience in leak detection methodology and systems. Yie, G.G. (Institute of Gas Technology, Chicago, Ill. (USA)). Mar 1977. 44p. of Gas Technology, Chicago, IL.

Reportable (serious) leaks in the nation's liquid pipelines are summarized in a table for the years 1968 to 1975. Criteria are listed for an ideal leakage detection system, and available and potential methods are reviewed. Pertinent IGT research projects are discussed, particularly their sonic leak pinpointing studies. IGT facilities, equipment, and personnel are described. The willingness of IGT

to study leak detection for petroleum as well as gas pipelines is emphasized. (DLC)

55819 Transportation of liquids. Dimentberg, M. US Patent 4,024,720. 24 May 1977. Filed date 4 Apr 1975. 6p.

Low temperature liquefied gases such as natural gas are usually transported at temperatures of approximately -258°F and at atmospheric pressures. If it is desired to transfer such liquids in pipelines, high cost materials must be used in pipeline construction and high contraction stresses are encountered requiring incorporation of contraction loops and bellows. Considerable savings will occur if the pipeline operates at intermediate temperatures of between -200° and -120°F and at a pressure sufficient to maintain the liquid phase within this temperature range. This permits lower cost materials to be used in the pipeline construction and eliminates the necessity of contraction loops and bellows.

55820 Pipeline system for more natural gas from the North Sea. Dafter, R. (Financ Times, London, Engl). *Erdoel-Erdgas Z.;* **93**: No. 3, 105-107(Mar 1977).

The British government is now contemplating a project calling for construction of a large natural gas gathering pipeline system in the North Sea. Good long-term prospects are seen for the project which would provide the British gas industry with some advantages in the third stage of offshore reserves exploitation. The project, which would cost in excess of 2-billion pounds Sterling and would involve the installation of 1,300 km of pipeline (the same length as the Trans Alaska oil pipeline), is briefly described.

55821 Calculation of nonstationary gas network using the Ganesi program system. Schmidt, G.; Weimann, A. (Tech Univ, Munich, Ger). *Gas- Wasserfach, Gas-Erdgas;* **118**: No. 2, 53-57(Feb 1977). (In German).

Modelling program is demonstrated on practical calculation in a dynamic way showing operation of pressure and flow regulators, compressors, and valves. Nonlinear hyperbolic differential equations are used. 16 refs.

55822 Nonstationary gas network calculation: simulation and comparative measurement. Eibl, K.; Stahlknecht, R.; Weimann, A. (Tech Univ, Munich, Ger). *Gas- Wasserfach, Gas-Erdgas;* **118**: No. 2, 57-63(Feb 1977). (In German).

Pipeline section selected for measuring is delineated, and sites of pressure, temperature, and mixing flow-through measurements are determined. The GANESI program system is used for simulation after verification of parameters. Model equations are solved numerically. 5 refs.

55823 Ocean transport and storage of liquefied natural gas. Reker, F.J. *Aluminium (Duesseldorf);* **53**: No. 2, 120-126(Feb 1977). (In German).

A report is given of the application of aluminum in the building of large ships' tanks for the transport of liquefied natural gas. This includes descriptions of the development of the AlMg 4.5 Mn alloy used and of the welding technique and filler metal employed. Cube-shaped and spherical tanks and different tank systems, such as the conch systems, Esso system, and the Moss-Rosenberg system are reviewed. 41 refs.

55824 Some problems of hydraulic calculation of gas pipelines transporting gas and air mixture. Krivitskaya, N.A. (B SSR Polytech Inst). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 1, 139-143(1977). (In Russian).

The use of a propane-butane gas and air mixture to supply gas to consumers in urban and rural localities is recommended. The problem of shipment of the gas and air mixture viz gas pipelines is considered and relations for their hydraulic calculation are proposed.

55825 Measuring fluid flow by vortex shedding. *Gas World Gas J.;* **181**: No. 4697, 673, 675(Dec 1976).

Use of the phenomenon of vortex shedding to measure fluid flow in liquid and gas pipelines is examined. Vortex shedding as a flow rate device can be used in pipes of any size --36 in. is mentioned as an indication of the upper limit. Advantages and disadvantages of the vortex meter under cryogenic conditions are also discussed.

55826 Modern mobile radio system. Coote, D.R.; Weedham, S.H.; Timmings, H.E. (North Thames Gas, Engl). *Gas World Gas J.;* **181**: No. 4694, 520, 522-523(Sep 1976).

Although, over the last 25 years, North Thames Gas has progressively improved and greatly extended its mobile radio networks, the stage has now been reached when the whole system must be replaced. The replacement must take account not only of the reorganized structure of the region, the changing operational patterns, and the raised standards of service and public safety, but also the increasing need to install systems that will assist employees to be as effective and speedy in their work as possible. Design features of the proposed mobile radio system are reviewed.

PROPERTIES

REFER ALSO TO CITATION(S) 55802, 55815

55827 Mercury titration in natural gas by flameless atomic absorption. La Villa, F.; Pean, Y. (Inst Fr de Pet). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 1, 89-101(Jan-Feb 1977). (In French with English abstract).

The method requires a mercury extraction either in the form of mercuric ions by making the gas pass through an oxidizing solution or in the form of amalgam with gold or silver. The former operating method applies to samples having a mercury concentration greater than 1 $\mu g/Nm^3$, and the latter for concentrations smaller than 5 $\mu g/Nm^3$. Detection thresholds are respectively 10 ng (in solution) and 0.3 ng (in amalgam). The repeatability for 100 ng of mercury (in amalgam) is + or - 7% with a probability of 95%. In a sample of natural gas, considering the volume of the samples taken, it is possible to detect concentrations in the vicinity of one nanogram of mercury per cubic meter of gas. 7 refs.

COMBUSTION

REFER ALSO TO CITATION(S) 55723, 55724, 57031, 57041

STORAGE

REFER ALSO TO CITATION(S) 55812

55828 Requirements for salt cavity stability analysis. Lux, K.H.; Rokahr, R.B.; Lorenzen, H. (Tech Univ, Hannover, Ger). *Erdoel-Erdgas Z.;* **93**: No. 2, 67-72(Feb 1977). (In German).

Salt caverns can be used for a variety of storage purposes, including gas storage, but this requires adequate calculation methods for the rock mechanical behavior and for the proof of cavern stability. A general calculation concept and model are proposed to contribute to the elements of the theoretical investigation of the stability behavior of caverns in salt rock. For solution by approximation of non-linear equations concerning the stresses and strains in the rock, the finite-element method is applied. Results show that realistic evidence can be obtained on stress and strain fields by the finite-element method. 13 refs.

OIL SHALES AND TAR SANDS

55829 Shale tomorrow. I. The world situation. Le Goff, Y. *Pet. Inf.;* No. 1398, 12-15, 34(Jun 1976). (In French).

A survey covers the difficulty of determining profitability, the change in the economic situation since the 1973 oil crisis, oil shale development in the world in 1838 to 1950, U.S. experience, including the Union Oil Corp. of California and Shale Oil Corp. retorting processes and the U.S. Bureau of Mines and Garrett Research and Development Co. Inc. in-situ processes, and developments in Brazil, including an imminent decision on the construction of a 50,000 to 100,000 bbl/day retorting plant.

SITE GEOLOGY AND HYDROLOGY

SITE GEOLOGY

REFER ALSO TO CITATION(S) 55746, 55841, 55842

55830 Geochemical provinces revealed in Toarcian oil shales in the eastern Paris Basin. Analysis of the soluble organic fraction. Huc, A.Y. (Univ Louis-Pasteur, Strasbourg, Fr). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **31**: No. 6, 933-953(Nov-Dec 1976). (In French with English abstract).

An analysis of soluble organic matter in the chloroform from Toarcian shales reveals the existence of a northern geochemical province and a southern geochemical province whose common boundary lies in the Fecocourt region. The northern province is characterized by the influence of the continental domain (Ardennes range) with regard to organic influx, whereas no terrestrial influx is found in the southern province. These findings agree with the sedimentological indications supplied by the literature and add a geochemical dimension to the paleogeography of this basin. 30 refs.

DRILLING, FRACTURING, AND MINING

55831 (SAND—77-0422C) **In situ oil shale fracturing experiment: some preliminary results.** Stevens, A.L.; Tyler, L.D.; Long, A. (Sandia Labs., Albuquerque, N.Mex. (USA); Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center). 1977. Contract EY-76-C-04-0789. 28p. (CONF-770440—9). Dep. NTIS, PC A03/MF A01.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, Colorado, United States of America (USA) (12 Apr 1977).

A series of field experiments was jointly undertaken aimed at developing techniques for producing and characterizing the extent and degree of fracturing in an oil shale formation. The first field experiment in this series is essentially completed. A description is given of the experiment and the instrumentation and analysis techniques for assessing the degree and extent of fracture and permeability produced. Preliminary results of the experiment indicate that an extensive degree of fracturing has been achieved but the resulting permeability is low. 9 figures, 1 table.

55832 (SAND—77-0779C) **Stress waves measured and calculated for in situ explosive rubblization experiments in oil shale.** Reed, R.P.; Boade, R.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 7p. (CONF-770617—1). Dep. NTIS, PC A02/MF A01.

From Colorado School of Mines meeting; Keystone, Colorado, United States of America (USA) (21 Jun 1977).

A three-part "bore-springing" experiment to rubblize Green River formation oil shale was conducted near Rock Springs, Wyoming. The experiment involved the detonation of a cylindrical explosive charge at the bottom of a 60 m deep well, the detonation of a second charge in the now expanded cavity of this same well, and the detonation of a third charge at the bottom of a similar well 5 m away. Transient stress in the oil shale was monitored with lithium niobate (piezoelectric) and ytterbium (piezoresistive) gages in wells 5 and 10 m from the explosive wells. The stress fields were also calculated using a two-dimensional wave code, CSQ. The paper correlates measurements and calculations, with emphasis given to borehole expansion, stress wave propagation, and fracture distribution. Realistic prediction of the stress field is demonstrated.

OIL PRODUCTION, RECOVERY, AND REFINING

55833 (CONF-7605160—1) **Status of tar sands conversion process technology and residuals management.** Dorrence, S.M. (Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center). 1976. 26p. Dep. NTIS, PC A02/MF A01.

From 1. symposium on management of residuals from synthetic fuels production; Denver, Colorado, United States of America (USA) (25 May 1976).

This is an overview of the state of the art of tar sand process technology and residual management. World resources, mining, and particularly processing are reviewed. In-situ processing methods are described in some detail. The processing environmental considerations involved are given. Residual management is next considered; the need for additional knowledge is pointed out. 28 figs. (DLC)

IN SITU METHODS, TRUE AND MODIFIED

REFER ALSO TO CITATION(S) 55756, 55831

55834 (UCID—17492) **Characterizing cinder rock with the scanning electron microscope.** Casey, A.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Feb 1977. Contract W-7405-ENG-48. 15p. Dep. NTIS, PC A02/MF A01.

Friable cinder rock was examined by scanning electron microscopy and energy dispersive x-ray analysis (SEM/ED). The technique consisted of impregnating the rock with epoxy resin and then locating porosity sites by the presence of epoxy. The resin was identified in the sample by correlating beam damage and elemental analysis by x-ray fluorescence (ED) with a characteristic phase in the SEM image. Analyses of this type should be useful in interpreting experiments designed to simulate in situ retorting.

55835 (UCRL—52256(Pt.1)) **Oil shale retorting. Part I. The effects of particle size and heating rate on oil evolution and intraparticle oil degradation.** Campbell, J.H.; Koskinas, G.H.; Coburn, T.T.; Stout, N.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Apr 1977. Contract W-7405-ENG-48. 47p. Dep. NTIS, PC A03/MF A01.

The evolution of oil during pyrolysis of blocks and powders of oil shale was investigated using heating rates from 2 to 180°C/h. Blocks (in the form of right circular cylinders) ranged from 3.2- to 17-cm diam, and from 14 to 49 gal/ton in grade. Results show that coking reactions are the major source of intraparticle oil degradation. Furthermore, the degree of coking depends strongly on the heating rate but is nearly independent of particle size and grade for the conditions used. For example, at a heating rate of 2°C/h, 83 percent of Fischer Assay oil is collected, whereas at a rate of 180°C/h the yield is 99 percent. These results are the same (to within +-2 percent) for both powders and 17.2-cm diam blocks. The experimental results from the 17.2-cm blocks are analyzed using a simple mathematical model based on kinetic results from powder retorting experiments and thermal data reported in the literature. The model calculations for the rate of oil production, the degree of oil degradation, and the thermal profile through the material are found to agree very closely with the experimental data. Finally, the practical implications of this work toward field retorting are discussed.

55836 (UCRL—79034) **Dynamics of oil generation and degradation during retorting of oil shale blocks and powders.** Campbell, J.H.; Koskinas, G.H.; Coburn, T.T.; Stout, N.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Apr 1977. Contract W-7405-ENG-48. 56p. (CONF-770419—3). Dep. NTIS, PC A04/MF A01.

From 10. oil shale symposium; Golden, Colorado, United States of America (USA) (21 Apr 1977).

The evolution of oil during pyrolysis of blocks and powders of oil shale was investigated using heating rates from 2 to 180°C/h. Blocks (in the form of right circular cylinders) ranged in size from 3.2 to 17.2 cm in diameter and from 58 to 204 l/t (14 to 49 gal/ton) in grade. The results show that coking reactions are the major source of intraparticle oil degradation. Furthermore, the degree of coking depends strongly on the heating rate, but is nearly independent of particle size and grade for the conditions used. The experimental results from the 17.2 cm blocks are analyzed using a simple mathematical model based on kinetic results from powder retorting experiments and thermal data reported in the literature. The model calculations agree closely with the experimental data. Finally, the practical implications of this work for field retorting are discussed.

55837 (UCRL—79149) **Modified in-situ oil shale technology at the Lawrence Livermore Laboratory: experimental results and present status.** Lewis, A.E.; Rothman, A.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Apr 1977. Contract W-7405-ENG-48. 14p. (CONF-770440—2). Dep. NTIS, PC A02/MF A01.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, Colorado, United States of America (USA) (12 Apr 1977).

An experimental effort is in progress to obtain a comprehensive understanding of the oil shale retorting process. Recent results have increased understanding of the mechanism of yield loss, the decomposition of carbonate minerals, and the reaction of char with O_2 and CO_2. A computer model has been compared successfully with retort experiments and is proving useful in optimizing the process and in designing further experiments. 13 figs.

55838 **Method of in situ recovery of viscous oils and bitumens.** Allen, J.C. (to Texaco Inc.). US Patent 4,026,358. 31 May 1977. Filed date 23 Jun 1976. 6p.

A method is given for recovering low-gravity viscous oils and bitumen hydrocarbons from a subterranean hydrocarbon-bearing formation by injecting thereinto a hydrocarbon solvent saturated with a gas, and thereafter establishing a thermal sink in the formation, followed by a soak period, and production of the hydrocarbons therefrom. 14 claims.

55839 **Hydrothermally forming a flow barrier in a leached subterranean oil shale formation.** Drinkard, G. (to Shell Oil Co.). US Patent 4,026,360. 31 May 1977. Filed date 12 Aug 1976. 6p.

Shale oil can be produced from a naturally fractured and leached subterranean oil shale formation by reacting the formation components with a hot aqueous alkaline liquid to form and distribute clay-like materials which can be water-swollen to form a flow barrier along or around a selected portion of the oil shale formation. Such flow barriers can guide or confine fluids that are injected and produced to recover shale oil. 5 claims.

55840 **Producing shale oil by flowing hot aqueous fluid along vertically varied paths within leached oil shale.** Closmann, P.J. (to Shell Oil Co.). US Patent 4,026,359. 31 May 1977. Filed date 6 Feb 1976. 4p.

In producing shale oil from a relatively permeable leached zone within a subterranean oil shale deposit, hot aqueous fluid is flowed between wells along paths which are vertically varied. An initial flow between near-bottom injection and production locations within the leached zone is varied by steps inclusive of producing fluid from a near-top location and injecting fluid into the initial production location. 6 claims, 3 figures.

55841 **Importance of reservoir description in evaluating in-situ recovery methods for Cold Lake heavy oil. II. In-situ application.**

Towson, D.E. (Petro-Can Explor Inc, Calgary, Alberta). *J. Can. Pet. Technol.;* **16**: No. 1, 48-54(Jan-Mar 1977).

Part 2 considers the application of reservoir description in evaluating in-situ recovery methods with specific reference to the Cold Lake deposit. It discusses in general terms the significance of the reservoir parameters and relates them to current technology and four of the most commonly proposed in-situ recovery concepts: steam stimulation, steam drive, in-situ combustion and the use of solvents. The reservoir description then serves as a basis of comparison of the recovery concepts for each of the five Cold Lake reservoir types described in Part 1. 5 refs.

55842 Importance of reservoir description in evaluating in-situ recovery methods for Cold Lake heavy oil. I. Reservoir description. Kendall, G.H. (Imp Oil Ltd, Calgary, Alberta). *J. Can. Pet. Technol.;* **16**: No. 1, 41-47(1977).

The huge reserves of heavy oil in Alberta are found in a variety of complex reservoirs. Recovery, excluding mining, will require application of some form of in-situ methods, primarily in the better reservoirs. The proper selection of an in-situ method, applicable to the various reservoir types, requires a basic understanding of reservoir description and the engineering aspect of the reservoirs. In Part 1 of this paper, reservoir description in the Cold Lake heavy oil deposits is discussed under three headings: (1) rock properties; (2) fluid saturation ; and (3) reservoir geometry. Based on these parameters, five selected reservoir types are discussed and compared. 13 refs.

SURFACE METHODS

55843 Method for extracting oil from oil shale. Prull, P.E. US Patent 4,028,222. 7 Jun 1977. Filed date 23 Feb 1976. 4p.

A method is given for extraction of oil from oil shale in which the shale is first crushed and then classified by a rotating trammel screen into four separate portions of differing longest particle dimension, namely less than 1/4 inch, less than 1/2 inch, less than 3/4 inch and greater than 3/4inch, with the first three portions being treated while passing through the trammel screen and each portion then separately centrifuged under conditions of centrifuge speed, time and added heat optimal for shale particles of that size. The fourth portion is recrushed. The applied heat may be dry heat, dry steam or wet steam, and the temperature range lies between 200°F and the flash point of the oil to be reextracted from the shale. Pressures ranging from atmospheric to slightly above atmospheric may be applied. 9 claims, 2 figures.

REFINING

55844 Low-pressure hydrocracking of a mixture of light fractions of shale and pyrolysis tars. Titushkin, V.A.; Gavrilov, N.N.; Denisenko, V.A. *Zh. Prikl. Khim.;* **48**: No. 10, 2257-2260(1975). (In Russian).

Low-pressure hydrocracking of a mixture of light fractions of shale and pyrolysis tars was conducted experimentally on a 75 to 120°C cut using continuous hydrocracking at 450° to 550°C, 5 to 20 atm, hourly space velocity 0.3 to 0.7, and hydrogen rate of 1000 l/kg of feedstock. The study was oriented toward good yields of benzene, low in thiophene and other impurities. The commercial alumina-molybdena catalyst remained fully active with respect to thiophene conversion throughout the 90 hour run, but less so toward n-heptane and cyclohexane. After 90 hours, the catalyst was fouled with 7.95% carbon and 2.90% sulfur.

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 55723, 55724, 55830

55845 Contribution of different chemical functions in the 1710, 1630, and 3,430 cm^{-1} infrared absorption bands of kerogens. Robin, P.L.; Rouxhet, P.G. (Univ Cathol de Louvain, Belg). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **31**: No. 6, 955-977(Nov-Dec 1976). (In French with English abstract).

In order to estimate the contribution of various functional groups to certain infrared absorption bands of kerogen, measurements are made of the absorption coefficient variations, resulting from chemical treatments that specifically affect the groups concerned. The treatments used for transforming the hydroxyl groups, responsible for the band of 3430 cm$sup -1$, are not very effective; however the study of two other bands is more successful. The respective contribution of carbonyl groups, acids and esters to the band at 1710 cm$sup -1$ can be determined. It is also possible to estimate the contribution of molecular water quinone carbonyl groups, olefin type unsaturations and vibrations of aromatic rings to the band at 1630 cm$sup -1$. Kerogens can thus be characterized by a method that is complementary to elemental analysis by providing a sort of functional analysis. The method described does not consume large amounts of material; it is straightforward, fairly quick and well suited for a comparative analysis of series of samples. 40 refs.

55846 Nitrogenous substances of kerogen in Estonian dictyonemic shales. Nappa, L.A.; Fomina, A.S. (Inst. of Chemistry, Tallin). *Khim. Tverd. Topl.;* No. 4, 98-103(1975). (In Russian).

The Lower Ordovician graptolitic argillites occur in overburden over phosphorites that are excavated in the Toolse-Azeri field in Estonia. The kerogen content in the argillites is 3 to 17 percent, with a 12 percent average; it contains 64.2 to 69.9 percent of carbon, 6.5 to 8.0 percent of hydrogen, 1.6 to 3.5 percent of nitrogen, and 18.6 to 27.5 percent of oxygen plus sulfur and chlorine. The highest values for amino acids in the argillites were found for glycine, leucine, and serine, and the lowest for methionine and cysteine. Regional differences are also shown.

55847 Composition of heavy shale oil...characterization of thermolysis products of the acid part of the shale. Klesment, I.; Rikken, J. (Inst. of Chemistry, Tallin). *Izv. Akad. Nauk Est. SSR, Khim. Geol.;* **24**: No. 3, 243-245(1975). (In Russian).

The composition of aromatic hydrocarbons from the acid part of the heavy shale oil was similar to that of the neutral part. Pyrolysis products had a high content of C_{14} and C_{16} 1-olefins and n-alkanes with an odd number of carbon atoms. The amount of even number carbon atoms increased considerably with increase in chain length from C_{18} to C_{17}. Aliphatic C_{11} - C_{17} chains attached mostly to resorcinol structures might have formed from C_{18} - C_{24} fatty acids present in some sea organisms and characterized by a high unsaturation.

55848 Quantitative determination of dawsonite in Green River shale by powder-sample x-ray diffraction: effect of grinding. Zen, E.; Hammerstrom, J.G. *J. Res. U.S. Geol. Surv.;* **3**: No. 1, 21-30(1975).

Weighed mixtures of drawsonite + quartz and of dawsonite + quartz + shale were ground for preset lengths of time, after which the following x-ray diffraction peaks were measured for intensity: dawsonite (110) at 15.6° 2theta and (211) (002) at 32.1° 2theta, and quartz (100) at 20.9° 2theta and (101) at 26.6° 2theta. Heights and areas were measured. Intensity ratios, plotted as functions of grinding time with a calculated probable error, generally decrease as grinding time increases. The intensity of the 15.6° peak is most affected, and the most drastic reduction occurs during the first 20 minutes of grinding. The 32.1° peak is least sensitive to grinding, but is subject to interference by other minerals in the shale. Accordingly, x-ray diffraction does not appear well adapted to routine quantitative determination of dawsonite in oil shale of the Green River Formation.

55849 High-sulfur shale oils. VII. Pailer, M.; Hlozek, V. (Univ., Vienna). *Monatsh. Chem.;* **106**: No. 6, 1259-1284(1975). (In German).

High-sulfur shale oils were analyzed using countercurrent distribution and chromatographic techniques; homologs of classes of compounds previously identified were isolated and characterized by spectroscopic methods. Phenyl and thienyl naphthalenes and benzothiophenes were also identified.

DIRECT USES AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 55988, 55989, 55990

55850 Effect of shale-tar additives on the antiwear properties of motor oils. Zelenin, N.I.; Gulin, E.I. *Khim. Tekhnol. Topliv Masel;* No. 12, 43-45(1975). (In Russian).

The wear of bushings was decreased by the addition of 3% ashless SP-2 (a shale tar fraction boiling 350 to 400°C) to lubricating oils, which synergistically increased the antiwear properties of other additives in the oil.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 56923

ENVIROMENTAL ASPECTS

55851 (IES—48) Oil shale development in northwestern Colorado: water and related land impacts. Water resources management workshop. (Wisconsin Univ., Madison (USA). Inst. for Environmental Studies). Jul 1975. 254p. of Wisconsin, Inst. for Environmental Studies, Madison, WI.

This study was made to examine the difficulties and benefits of an interdisciplinary inquiry into current and planned oil shale development, to determine and record data pertaining to land and water uses with and without various levels of oil shale extractive technology in the Piceance Creek Basin, and to assist the local and

regional governments in the basin in planning for secondary impacts on the social, cultural, and economic framework of the area. 24 fig, 76 tables, 14 maps. (DLC)

FISSION FUELS

RESERVES

REFER ALSO TO CITATION(S) 57196

55852 Outlook for uranium and enrichment supply in the United States. Cherry, B.H. *Combustion;* **48**: No. 12, 40-43(Jun 1977).

From 39. annual meeting of the American Power Conference; Chicago, IL, USA (18 Apr 1977).

The relationship between uranium and enrichment supplies is discussed, and the adequacy of the supplies is evaluated. Recommendations are offered to improve the stability of the enriched uranium supply complex so that the nuclear industry could advance with confidence in the adequacy of its supplies. (DDA)

55853 Uranium exploration '75. Ottawa; Geological Survey of Canada (1975). 80p. .

From 43. annual convention; Toronto, Canada (11 Mar 1975).

Nuclear energy offers a viable solution to the major energy problem that faces the world. This publication comprises five papers that were presented orally to the Prospectors and Developers Association in March 1975. The main emphasis is on geoscience applied to uranium exploration, but one paper considers projected demand and the conclusion reached is that presently known conventional types of uranium deposit will not meet future needs. The geological features of some lesser known types of deposits are considered and the various aspects of geophysics and geochemistry that can be applied to current uranium exploration programs are discussed. The concluding paper describes the Federal-Provincial Uranium Reconnaissance Program which begins in the summer of 1975.

EXPLORATION

REFER ALSO TO CITATION(S) 55750, 57197, 57198

55854 (DPST—77-138-2) Hydrogeochemical and stream sediment reconnaissance: eastern United States. Savannah River Laboratory quarterly report, April—June 1977. National Uranium Resource Evaluation program. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1977. Contract EY-76-C-09-0001. 52p. (GJBX—55(77)). Dep. NTIS, PC A04/MF A01.

Progress is reported in geological programs; laboratory analyses; data management, analysis, and interpretation; and reporting. A priority ordering of quadrangles was received. Reconnaissance ground water sampling is 55% complete for FY 1977. Surface sampling and orientation studies were begun. Study of Chattanooga shale shows that stream sediments are little affected beyond 300 m downstream in a region with outcrops averaging 84 ppM U. Dark shale coastal plain samples from S.C. to N.J. averaged 4.5 ppM U, with none exceeding 9.2 ppM. Neutron activation analysis (NAA) rate was more than doubled, with over 7500 samples activated in 2 months; a full-scale NAA facility is under construction. (DLC)

55855 (STI/PUB—450) Recognition and evaluation of uraniferous areas. Panel proceedings series. (International Atomic Energy Agency, Vienna (Austria)). 1977. 295p. (In Spanish and English). (CONF-7511132—). IAEA $21.00.

From Technical committee meeting on recognition and evaluation of Uraniferous areas; Vienna, Austria (17 Nov 1975).

Sessions were held on the distribution of uranium during formation of the earth's crust and crystallization of magmas, distribution of uranium in rocks as a guide to the recognition of potential uranium ore deposit districts, metallotectonic control of uranium distribution, and recognition of uraniferous areas and evaluation of their uranium potential. (LK)

55856 (UCID—16911-77-1) Hydrogeochemical and stream-sediment survey of the National Uranium Resource Evaluation (NURE) program: western United States. Quarterly progress report, January—March 1977. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Jun 1977. Contract W-7405-ENG-48. 17p. (GJBX—53-77). Dep. NTIS, PC A02/MF A01.

A reconnaissance sampling project in west-central Utah (833 sites) was completed and another in southern Nevada and southeastern California (1500 sites) was begun. Planning and site selection have begun for a sampling project covering a 150,000-km^2 (58,000-mi^2) area in Nevada, California, and Utah. Contracts for about 5000 of the sites in this area will be granted in the next few months. New office, laboratory, and sample storage facilities at LLL are now in use. We have installed a delayed-neutron counter and an instrumental neutron-activation analysis system in our automated sample analysis facility. A plasma-source, optical-emission spectrometer has also been installed and will be fully operational next quarter. Several improvements have been made in computer programs to facilitate data acquisition, analysis, storage, and openfile reporting. Software development and calibration work are continuing, and the facility should be ready for full-scale operation (27,000 samples per year) sometime next quarter.

55857 Spatial dependence of delayed-neutron signals from uranium exploration probes. Smith, R.C. (Westinghouse Research Labs., Pittsburgh); Rodriguez, R.G. *Trans. Am. Nucl. Soc.;* **26**: 163-165(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55858 Uranium exploration methods development. Grutt, E.W. Jr. (ERDA, Grand Junction, Colo). *Min. Congr. J.;* **63**: No. 4, 60-67(Apr 1977).

New and improved technology is being developed to support exploration by industry and the on-going Uranium Resource Assessment Program of the Energy Research and Development Administration (ERDA). These developments range from modest improvements on established and relatively simple methods, such as gross gamma counting with portable instruments, through application of advanced state-of-the-art techniques, such as high sensitivity gamma-ray spectrometry, to research and development of new sophisticated measurement systems, such as direct uranium logging using neutron interrogation. 17 refs.

55859 Gamma-ray measurement and data reduction considerations for airborne radiometric surveys. Breiner, S.; Lindow, J.T.; Kaldenbach, R.J. (GeoMetrics/Exploranium, Sunnyvale, Calif., USA). pp 93-104 of In Exploration for uranium ore deposits. Proceedings of a symposium on exploration of uranium ore deposits organized by the IAEA and the OECD Nuclear Energy Agency and. Vienna; IAEA (1976).

From Symposium on exploration of uranium ore deposits; Vienna, Austria (29 Mar - 2 Apr 1976).

Approximately six million line kilometers of airborne gamma-ray surveys are about to commence, most of which will utilize large crystal detectors, multichannel spectrometers and complex data reduction procedures. Many problems remain, however, for the successful application of these surveys to uranium exploration. Among these problems are poor gamma-ray count statistics, weak geological signals, excessive background and inadequate procedures for removing the effects due to the background. Recent developments in the configuration and application of crystal detectors and computer-based, multichannel gamma-ray spectrometers are suggested as possible means for minimizing several of these problems.

MINING

55860 Utah's uranium mines operated by new company as merger requirement. *World Min.;* **3**: No. 4, 50-52(Apr 1977).

When Utah International became a wholly owned subsidiary of the General Electric Company on December 20, 1976, a special provision of the merger was that Utah and General Electric would divest themselves of Utah's uranium operations. A new wholly-owned subsidiary of Utah was established, Lucky McUranium Corporation, to manage and operate Utah's uranium properties. The article briefly describes the operations.

55861 Portable instrument measures four ventilation parameters. McVey, J.R.; Franklin, J.C.; Shaw, D.M. (US Bur of Mines). *Min. Congr. J.;* **63**: No. 4, 49-52(Apr 1977).

Radon gas seepage into mine ventilation systems and into work areas having marginal ventilation is a major problem to the uranium mining industry. A four-parameter measurement system for accurate determination of relative humidity, temperature, mine pressure and ventilation velocity has been developed for use in the radon gas control research of the U.S. Bureau of Mines. The new unit is housed in a 17 by 20 by 8-in. suitcase weighing less than 15 lb.

FEED PROCESSING

REFER ALSO TO CITATION(S) 55935, 55940

55862 Recovery of uranium sulfate anions on a weak base anion exchange resin. Yarnell, P.A. (to Rohm and Haas Co.). US Patent 4,026,987. 31 May 1977. Filed date 11 Oct 1974. 6p.

A process for recovering uranium as an anionic sulfate complex from sulfuric acid leach liquors is disclosed and claimed. A novel weak base anion exchange resin is used in this process.

55863 Carbonate leach uranium ore processing with sodium polyacrylate flocculant. Finch, R.E.; Scala, R.H. (to Nalco Chemical Co.). US Patent 4,024,216. 17 May 1977. Filed date 2 Jul 1975. 4p.

Uranium yields, derived from alkaline leaching of a uranium ore, are increased and at the same time the need for fresh water to dissolve a flocculant is eliminated by using sodium polyacrylate as the flocculant, diluted with and dissolved by system water.

55864 Production of uranium dioxide. Knudsen, I.E. (to Westinghouse Electric Corp.). US Patent 4,020,146. 26 Apr 1977. Filed date 5 Jul 1973. 12p.

A three stage fluidized bed process is described for converting uranium hexafluoride (UF_6) to a ceramic-grade uranium dioxide (UO_2) powder by first, reacting hydrogen and steam with UF_6 in a first fluidized bed in a temperature range of from about 475 to 600°C to form solid intermediate products UO_2F_2 and U_3O_8; second, reacting hydrogen and steam with the intermediate products in a second fluidized bed at a temperature ranging from about 575 to about 675°C to produce a second group of intermediate products including UO_2F_2, U_3O_8, and UO_2; and, third, reacting hydrogen and steam with the second group of intermediate products in a third fluidized bed as a temperature of 575 to 675°C to produce ceramic grade UO_2 powder having low residual content of fluorides and other foreign materials. 9 claims, 1 figure.

ENRICHMENT

REFER ALSO TO CITATION(S) 55852, 57227

55865 Enrichment prospects for the 1980's. Rippon, S. *Energy Int.;* **14**: No. 5, 41-44(May 1977).

U.S. enrichment plants, European diffusion projects, and European centrifuge projects are discussed. (LK)

LASER EXCITATION

REFER ALSO TO CITATION(S) 57621

55866 Evaporator. (to Jersey Nuclear-Avco Isotopes, Inc., Bellevue, Wash. (USA)). German(FRG) Patent 2,543,881/A/. 22 Apr 1976. 19p. (In German).

2 figs.

If uranium is vaporized there are corrision effects if the liquid metal acts on the walls of the crucible. In order to avoid this it is proposed to embed the material to be vaporized (uranium) within a porous matter in an electron-beam evaporator, this matter having a lower vapor pressure (tungsten); thus the formation of thermal convection is prevented as far as possible. Further, the material to be vaporized is heated or liquefied only in lumps. The invention is discussed in detail on the example of an evaporator for uranium metal and a device for isotope-selective ionization for uranium enrichment. The former equipment is also suited for vaporization of aluminium enclosed by tantalum carbide.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 55864, 55936, 55945, 55965, 56539

55867 (CONF-770537—2) **Thermodynamic functions and vapor pressures of uranium and plutonium oxides at high temperatures.** Green, D.W.; Reedy, G.T.; Leibowitz, L. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 28p. Dep. NTIS, PC A03/MF A01.

From 7. symposium on thermophysical properties; Gaithersburg, Maryland, United States of America (USA) (10 May 1977).

The total energy release in a hypothetical reactor accident is sensitive to the total vapor pressure of the fuel. Thermodynamic functions which are accurate at high temperature can be calculated with the methods of statistical mechanics provided that needed spectroscopic data are available. This method of obtaining high-temperature vapor pressures should be greatly superior to the extrapolation of experimental vapor pressure measurements beyond the temperature range studied. Spectroscopic data needed for these calculations are obtained from infrared spectroscopy of matrix-isolated uranium and plutonium oxides. These data allow the assignments of the observed spectra to specific molecular species as well as the calculation of anharmonicities for monoxides, bond angles for dioxides, and molecular geometries for trioxides. These data are then employed, in combination with data on rotational and electronic molecular energy levels, to determine thermodynamic functions that are suitable for the calculation of high-temperature vapor pressures.

55868 (PNCT—841-75-37) **PURSE: plutonium radiation source code.** Aoki, T.; Yumoto, R.; Sasajima, H.; Fukuda, S. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Sep 1975. 61p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

A computer code was programmed to know the properties of radiations from plutonium, fuel and to calculate the energy distribution of γ-ray. The program contains a series of the equations for decay chains, and takes the present reliability of nuclear data into consideration. This program can be applied to the handling of plutonium in the course from the reprocessing to the loading into reactors. The considered plutonium isotopes are Pu-236, Pu-238, Pu-239, Pu-240, Pu-241 and Pu-242. The nuclear data of these nuclides, namely half-life, gamma-ray yield and energy, neutron yield and others, were taken from the Table of Isotopes, Nuclear Data Tables and the ANL-5800. The disintegration rate of alpha, beta and gamma decay of all nuclides in consideration and emitted energy are calculated as functions of time. As for gamma-ray, the maximum number of groups of energy is 15, and the total energy and the mean value of energy for each group are calculated. The neutron production yield is calculated as the sum of the neutron yield by spontaneous fission and the yield by the (α, n) reaction with oxygen. The PURSE is programmed for CDC6600, and the time for computation is about 1 min for one case.

55869 Fuel particles with coatings without property gradients. Huschka, H.; Schmutz, H.; Vygen, P. (to Nukem GmbH). US Patent 4,028,181. 7 Jun 1977. Priority date 23 Jul 1970, German, Federal Republic of (F.R. Germany). 6p.

Fuel particles in a fluidized bed are provided with a coating of pyrolytic carbon having substantially no property gradients by holding the speed of growth constant during the entire coating time and ensuring the same speed of growth in all particles of the particle bed.

55870 Method and device for the fabrication of nuclear fuel compacts. Bujas, R. (to Commissariat a l'Energie Atomique). US Patent 4,028,446. 7 Jun 1977. Priority date 3 May 1974, France. 6p.

In a method for the fabrication of nuclear fuel compacts, a cylindrical mold is filled with coated particles containing fissile and fertile material as well as grains of graphite if necessary. The mold is heated to a temperature above the softening temperature of pitch which is injected into the mold in the hot state through openings provided at regular intervals along the mold wall and having a diameter which is smaller than the size of the coated particles, the injection of pitch being carried out at right angles to the generator-lines of the cylinder formed by the mold.

55871 Particle cavitation during hydrogen reduction of mixed-oxide fuel. Olander, D.R. (Univ. of California, Berkeley). *Trans. Am. Nucl. Soc.;* **26**: 167-168(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55872 Improved gas distributor for coating HTGR fuel particles. Lackey, W.J.; Stinton, D.P.; Sease, J.D. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 303-304(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55873 Determination of optimal composition of nondeliverable fabrication plant fuel material. DePorter, E.L.; Nachlas, J.A.; Kurstedt, H.A. Jr. (Virginia Polytechnic Inst. and State Univ., Blacksburg). *Trans. Am. Nucl. Soc.;* **26**: 304-305(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55874 Preparation of mixed oxide nuclear fuel. Feraday, M.A. (to Atomic Energy of Canada Ltd.). US Patent 4,020,131. 26 Apr 1977. Priority date 28 Feb 1975, Canada. 4p.

A method is described for the preparation of UO_2-PuO_2 nuclear fuel pellets. Green pellets of the basic fuel material, UO_2, are fabricated by standard powder metallurgy techniques. After sintering at a temperature of 1100 to 1400°C, the pellets are ground or machined to a suitable size prior to impregnation with a plutonium salt solution. After impregnation, sintering of the pellets at 1400 to 1700°C converts the plutonium salt to PuO_2. (BLM)

55875 Ammonia as a sintering aid for UO_2. Radford, K.C.; Pope, J.M. (Westinghouse Res Lab, Pittsburgh, Pa). *Am. Ceram. Soc. Bull.;* **56**: No. 2, 197-200(Feb 1977).

The effects of uncracked ammonia on various UO_2 poweder types are investigated. Ammonia is a sintering aid for UO_2 pellets. The enhancement in densification using NH_3 atmospheres includes a

reduction in sintering temperatures and a substantial increase in grain size. A redistribution and increase in size of the porosity occurs. Calcining UO_3 precursors (such as ammonium diuranate) in NH_3 results in a more active powder which produces a larger grain size in sintered structures than does calcining in hydrogen. Small additions of ammonium salts also result in similar enhancements in grain size. 23 refs.

55876 Kritikalitaetssicherheit bei der Herstellung und Handhabung von Kernbrennstoffen. Kritikalitaetsdaten fuer Uran 235-Dioxid-Leichtwasser-Mischungen. (Criticality safety in processing and handling fissile materials. Criticality data for uranium 235 dioxide light-water-mixtures). Berlin, Germany, F.R.; Beuth (Jan 1977). 6p. (In German).

5 figs.; 2 tabs.; 1 ref.

In the form of numerical data and graphical representations the smallest critical values for a system of uranium 235 dioxide homogeneously distributed in light water at maximum reflection through water are given.

55877 Kritikalitaetssicherheit bei der Herstellung und Handhabung von Kernbrennstoffen. Kritikalitaetsdaten fuer Plutonium 239-Dioxid-Leichtwasser-Mischungen. (Criticality safety in processing and handling fissile materials. Criticality data for plutonium 239-dioxide light-water-mixtures). Berlin, Germany, F.R.; Beuth (Jan 1977). 7p. (In German).

5 figs.; 3 tabs.; 1 ref.

In the form of numerical data and graphical representations the smallest critical values for plutonium 239-dioxide light-water-mixtures in dependence of the moderator-fuel ratio are given.

55878 Kritikalitaetssicherheit bei der Herstellung und Handhabung von Kernbrennstoffen. Kritikalitaetsdaten fuer Plutonium 239-Nitrat-Leichtwasser-Mischungen. (Criticality safety in processing and handling fissile materials. Criticality data for plutonium 239 nitrate light-water-mixtures). Berlin, Germany, F.R.; Beuth (Jan 1977). 7p. (In German).

5 figs.; 2 tabs.; 1 ref.

In the form of numerical data and graphical representations, the smallest critical values for a system of plutionium 239 nitrate homogeneously distributed in light water at maximum reflection through light water are given.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 55898, 55933, 55937, 55938, 56937

55879 (ARH—2127) Purex process operation and performance, 1970 Thoria Campaign. Jackson, R.R.; Walser, R.L. (eds.). (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Mar 1977. Contract EY-76-C-06-2130. 194p. Dep. NTIS, PC A09/MF A01.

The Hanford Purex Plant fulfilled a 1970 commitment to the Atomic Energy Commission to produce 360 kilograms of high purity ^{233}U as uranyl nitrate solution. Overall plant performance during both 1970 and 1966 confirmed the suitability of Purex for processing thorium on a campaign basis. The 1970 processing campaign, including flushing operations, is discussed with particular emphasis on problem areas. Background information on the process and equipment used is also presented. The organizations and their designations described are those existing in 1970.

55880 (DP—1429) Nuclear safety of the ten-well insert for the SRP fuel element dissolver. Perkins, W.C.; Forstner, J.L. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Jun 1977. Contract EY-76-C-09-0001. 35p. Dep. NTIS, PC A03/MF A01.

Mass limits are developed and presented for safe dissolution of fissile materials in the Ten-Well Insert, an improved device for limiting the configuration of fuel in SRP dissolvers. This insert permits high-capacity dissolution of SRP fuels, offsite fuels, and scrap fissile materials with adequate margins of nuclear safety. Limits were developed by calculating the safe (subcritical) mass per well as a function of the concentration of fissile material in the dissolver solution. Safe mass values were then selected for use as well-loading limits so as to ensure subcriticality throughout the dissolution. Well-loading limits are presented for uranium metal, uranium-aluminum alloy, U_3O_8-aluminum cermet, plutonium-aluminum alloy, and uranium-plutonium-aluminum alloy. With these limits, the maximum k/sub eff/ is 0.95. Nuclear safety is maintained in process operations by conforming to well-loading limits calculated from the safe mass values, conforming to dissolver-loading limits, and maintaining the concentration of fissile material in solution below 4.0 g/l. 9 figures, 14 tables.

55881 (DP-MS—76-77) Solvent extraction of enriched uranium fuels at the Savannah River Plant. Thompson, M.C. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1977. Contract EY-76-C-09-0001. 21p. (CONF-770907—2). Dep. NTIS, PC A02/MF A01.

From International solvent extraction conference; Toronto, Canada (9 Sep 1977).

A modified Purex process was developed in the Savannah River Laboratory and is now used routinely at the Savannah River Plant to recover enriched uranium (1 to <90% ^{235}U) and either plutonium or neptunium from irradiated fuel. Performance is improved over the previous process except for zirconium decontamination. Laboratory tests at lower scrub acid concentrations show that the zirconium decontamination can be improved. Modifications which further improve uranium-neptunium partitioning have been tested in the laboratory, but not in the plant.

55882 (JAERI-M—6592) Purification process studies for the reprocessing by fluoride volatility method. (Japan Atomic Energy Research Inst., Tokyo). Jun 1976. 44p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

In the research and development program for the reprocessing by fluoride volatility method, the fluorination-purification process has been studied with a simulated FBR fuel containing UO_2-PuO_2 and non-radioactive fission products, in the 2"phi and 3"phi fluid-beds. Behaviors of fission products and other process problems in a proposed flow-sheet were clarified. Described are the flow-sheet aimed to study and its purification principle, experimental results of plutonium and uranium purifications, and analytical methods.

55883 Completing the nuclear fuel cycle. *Combustion;* **48**: No. 12, 34-39(Jun 1977).

The consequences of delay in recycling spent nuclear fuels are considered. The technology of recycling, transporting, and managing the material is reviewed; and the need for and mechanics of safeguard systems are discussed. (DDA)

55884 Process for separating ceramics of uranium and plutonium from zirconium by hydriding and mixtures thereof. Cech, B.; Kaderabek, E.; Hanslik, T. (to Ceskoslovenska Akademie Ved). US Patent 4,024,068. 17 May 1977. Priority date 24 Mar 1974, Czechoslovakia. 4p.

A process is provided involving the use of hydrogen for the separation of uranium and plutonium and mixtures thereof, from composite substances and assemblies or mixtures containing metallic and ceramic components where the metallic component is zirconium or a zirconium alloy and the ceramic component contains uranium and/or plutonium.

55885 Method of preparation for storage of liquids used in the reprocessing of spent nuclear fissile and/or fertile materials. Drobnik, S. (to Gesellschaft fuer Kernforschung mbH). US Patent 4,022,708. 10 May 1977. Priority date 5 Aug 1972, German, Federal Republic of (F.R. Germany). 12p.

A method of preparation for non-polluting storage of liquids containing phosphoric acid ester and hydrocarbons used in the reprocessing of spent nuclear fissile and/or fertile materials comprises adding concentrated H_3PO_4 to the waste liquid to form two phases, the lighter phase containing the hydrocarbon and the heavier phase containing the H_3PO_4, degradation products and radioactive materials. The lighter phase is washed with a sodium oxalate solution, treated with activated charcoal, and recycled by adding phosphoric acid ester to the purified hydrocarbon to form a fresh solution for fuel reprocessing. The heavier phase is treated to form a solidified waste product suitable for disposal. (BLM)

55886 Reactivity measurements under conditions typical to fuel element dissolution. Bierman, S.R. (Battelle Pac Northwest Lab, Richland, Wash). *Nucl. Technol;* **31**: No. 3, 339-347(Dec 1976).

The objectives of the measurements were to demonstrate the use of the pulsed neutron source technique for measuring the effectiveness of a neutron poison in reducing the reactivity of such a system and to determine the kinetic parameter $beta$/l for these systems. Reductions in k$sub eff$ from unity down to 0.64 were observed upon the addition of 1.34 g Gd/l to a critical system. Based on the prompt and delayed critical conditions determined for each gadolinium concentration, a continuous reduction, from $4.35/cm of solution depth down to $0.42/cm, was observed in the reactivity worth of the plutonium-uranium nitrate solution as gadolinium was added to the solution.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 55883, 55948, 55949, 55950, 56370, 56411, 56412, 57276, 57279, 57280

55887 Transportation regulatory revisions. Hopkins, D.R.; Barker, R.F. (Nuclear Regulatory Commission, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 249(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55888 Transportation R and D in ERDA's Division of Environmental Control Technology. Sisler, J.A.; Counts, J. (Energy Research and Development Administration, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 249(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55889 Transportation status and problems in the back end of the fuel cycle. Peterson, R.W. (Allied-General Nuclear Services, Barnwell, SC). *Trans. Am. Nucl. Soc.;* **26**: 251-252(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55890 Spent fuel storage in the USA. Woodhall, C.B. (Nuclear Assurance Corp., Atlanta); Hook, N.B.; Powell, F.P. *Trans. Am. Nucl. Soc.;* **26**: 253-254(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55891 Spent fuel storage: utility perspective. Cagnetta, J.P. (Northeast Utilities Service Co., Hartford). *Trans. Am. Nucl. Soc.;* **26**: 254(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55892 Spent fuel storage basis for new nuclear power plants. Rubinstein, H.J.; Clark, P.M.; Gilcrest, J.D. (Nuclear Services Corp., Campbell, CA). *Trans. Am. Nucl. Soc.;* **26**: 254-256(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 55860, 56596

55893 (ERDA—77-46) **Survey of United States uranium marketing activity.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Uranium Resources and Enrichment). May 1977. 33p. Dep. NTIS, PC A03/MF A01.

The 1977 survey requested data on U purchase commitments, U imports and exports, reactor fuel arrangements and unfilled requirements, inventories of domestic and foreign U, and prices for existing contracts between producers and buyers. The 207 U.S. power reactors in operation, under construction, or for which orders have been placed, are covered. Information was received from 70 utilities, 38 present or potential U producers, and 5 reactor manufacturers. Net additional procurement is 83,400 tons of U_3O_8, with direct involvement of the purchasers in almost half the cases. During 1976, average U prices increased substantially for 1976-77 and 1980-85 deliveries, but only minor changes for 1978 and 1979. Average delivery prices remain well below prices for new procurement. 12 tables, 7 figs. (DLC)

55894 Optimal set of selected enrichments that minimizes blending consequences. Kurstedt, H.A. Jr.; Lorber, J.; Nachlas, J.A. (Virginia Polytechnic Inst. and State Univ., Blacksburg). *Trans. Am. Nucl. Soc.;* **26**: 280(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55895 Uranium requirements for fuel cycles in expanding nuclear power systems. Banerjee, S. (McMaster Univ., Hamilton, Ontario); Tamm, H. *Trans. Am. Nucl. Soc.;* **26**: 280-281(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 55942, 55943, 55944, 56934, 57334

55896 (NUREG—0279) **Determination of performance criteria for high-level solidified nuclear waste.** Cohen, J.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Feb 1977. Contract W-7405-ENG-48. 203p. Dep. NTIS, PC A11/MF A01.

The purpose of this study is to identify and recommend performance orientated criteria and/or standards which, if applied, would reduce the risk to the environment and to the public health and safety due to solid HLW management operations including final disposal. The study will result in a two-part technical report describing the study and results and in an Environmental Impact Statement. This document (Part 1 of the technical report) describes the study approach, the calculational model developed, factors considered in the evaluation, and the preliminary results obtained to date. Part 2, which will contain the technical basis for the criteria recommended, is scheduled for completion in July 1977. The results obtained to date indicate that the pre-emplacement waste environs may be more limiting in establishing the waste-matrix performance criteria than the post-emplacement environs, considering both normal conditions and potential accident conditions. These results are based upon waste emplacement in a stable geologic repository but do not rely upon the repositories remaining intact over the potentially hazardous lifetime of the waste. Preliminary evaluations show the transportation phase of the waste management system to be potentially the most limiting due to both the variety of possible disruptive interactions and to demographic factors. These concerns may be partially, if not totally, mitigated by the large degree of protection afforded by the casks in which the wastes will be transported. A recommended format for specifying performance criteria oriented towards controlling radionuclide releases due to volatilization, particulate dispersion, and leaching was derived and is given. Numerical standards to be incorporated into the criteria will be derived in the subsequent phases of this study and published in part 2 of the technical report.

55897 Secure storage of radioactive waste. Dau, G. (Battelle Pacific Northwest Labs., Richland, WA); Williams, R. *Combustion;* **48**: No. 12, 24-32(Jun 1977).

The authors have reviewed available technology and have selected what appears to be the best of several alternatives at each step in the waste-handling process, as a technique for presenting the current status of the technology to the public and the industry. The process consists of the following sequence: fuel reprocessing; high-level liquid waste storage; two-step solidification; transportation and final disposal; and decontamination of fuel cladding and hardware residue. (auth)

WASTE PROCESSING

REFER ALSO TO CITATION(S) 55916, 55946, 55947

55898 (CONF-770354—1) **Report of the workshop on the technological implications of burning actinides to the fuel cycle.** Croff, A.G. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 5p. Dep. NTIS, PC A02/MF A01.

From 1. technical meeting on the nuclear transmutation; Ispra, Italy (16 Mar 1977).

Potential fuel cycle impacts resulting from partitioning-transmutation identified and discussed are: increased actinide neutron activity; fabrication and waste actinides; operational effluent releases; analysis of the benefits of partitioning-transmutation; cost of partitioning-transmutation; and analysis of incentives for partitioning-transmutation. (LK)

55899 (ERDA—76-162) **Management and storage of commercial power reactor wastes.** (Energy Research and Development Administration, Washington, D.C. (USA)). 1976. 39p. Dep. NTIS, PC A03/MF A01.

Summary basd on the ERDA technical alternatives document.

In May 1976, a technical document, ERDA—76-43, entitled "Alternatives for Managing Wastes from Reactors and Post-Fission Operations in the LWR Fuel Cycle" was published by the United States Energy Research and Development Administration. This 1500-page document describes technical alternatives for managing wastes from the commercial light-water-reactor fuel cycle. It does not select preferred waste management technologies or make comparative assessments. This report, ERDA—76-162, is a brief summary of the salient points in the 1500-page document and should provide an appreciation of the present technology and methods for handling the various forms of radioactive waste. In a major expansion of ERDA's waste management program, the U.S. has initiated efforts to identify acceptable geologic formations within the continental U.S. for ultimate disposition of reactor wastes. This technique represents the most advanced alternative presently available for the long-term management of these wastes.

55900 (ICP—1122) **Alternative fuel cycle technology progress report for April 1—June 30, 1977.** Slansky, C.M.; Dickey, B.R.; Musgrave, B.C.; Rohde, K.L. (Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs - Operations Office). Jul 1977. Contract EY-76-C-07-1540. 26p. Dep. NTIS, PC A04/MF A01.

Quarterly progress is reported on alternative fuel cycle technology studies for the Savannah River Laboratory. Off-gas studies are reported on the reaction between NO/sub x/ and NH_3 and on the adsorption of gaseous iodine on silver-exchanged mordenite. Waste management studies include the evaporation and corrosion behavior of simulated high-level liquid waste in a thermosiphon evaporator and engineering studies on a laboratory-size storage tank.

55901 (MLM—2436) **Volume reduction system for solid and liquid TRU waste from the nuclear fuel cycle: January—March 1977.** Luthy, D.F.; Bond, W.H. (Mound Lab., Miamisburg, Ohio (USA)). 27 Jul 1977. Contract EY-76-C-04-0053. 9p. Dep. NTIS, PC A02/MF A01.

Facilities generating radioactive waste and a fuel processor were contacted to obtain data on types and quantities of waste produced. The incinerator is being modified to allow the burning of liquid wastes. Ash immobilization studies continued with both glass and cement being tested for rendering the ash inert. A drum compactor fabricator has been located who can compress drums to meet program requirements.

55902 (UCRL—13733-1) **Estimates and sampling schemes for the instrumentation of accountability systems.** Jewell, W.S.; Kwiatkowski, J.W. (California Univ., Berkeley (USA). Operations Research Center). Oct 1976. Contract W-7405-ENG-48. 47p. (ORC—76-32). Dep. NTIS, PC A03/MF A01.

The problem of estimation of a physical quantity from a set of measurements is considered, where the measurements are made on samples with a hierarchical error structure, and where within-groups error variances may vary from group to group at each level of the structure; minimum mean squared-error estimators are developed, and the case where the physical quantity is a random variable with known prior mean and variance is included. Estimators for the error variances are also given, and optimization of experimental design is considered.

55903 **Remote maintenance equipment for the new waste calcining facility.** Jacobs, R.T. (Allied Chemical Corp., Idaho Falls, ID). *Trans. Am. Nucl. Soc.;* **26**: 288-289(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55904 **Recovery from spillage of calcined waste solids.** Zeamer, C.J. (Allied Chemical Corp., Idaho Falls, ID). *Trans. Am. Nucl. Soc.;* **26**: 289(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55905 **Immobilization of tritiated aqueous waste in polymer-impregnated concrete.** Neilson, R.M. Jr.; Colombo, P. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 290(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55906 **Linear accelerator fission product transmuter (LAFPT).** Steinberg, M.; Takahashi, H.; Ludewig, H.; Powell, J.R. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 293-294(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55907 **Conduction of heat in a cylindrical homogeneous medium with a moving source.** Castellani, F.; Curzio, G.; Gentili, A. (Univ di Pisa, Italy). *Termotecnica (Milan);* **31**: No. 3, 144-147(Mar 1977). (In Italian).

The conduction of heat produced by a source which moves through a cylindrical homogeneous medium is examined. The problem is strictly correlated to decay heat effects in a charcoal holdup bed for radioactive treatment of noble gases. An analytic solution by means of series of Bessel functions is proposed: a numerical solution and evaluation of errors are also reported.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 55728, 55899, 55932, 55946, 55951, 55952, 55953, 56801, 57329

55908 (ORNL/SUB—3706/2) **Analysis and evaluation of the rock mechanics aspects of the proposed salt mine repository. Summary progress report RSI-0005.** Gnirk, P.F.; Callahan, G.D.; Hovland, H.; Priseau, W.G.; Russell, J.E.; Wawersik, W.R. (RE/SPEC, Inc., Rapid City, S.Dak. (USA)). 28 Sep 1973. Contract W-7405-ENG-26-7405-26-3706. 161p. Dep. NTIS, PC A08/MF A01.

Numerical and experimental results have been further refined. Analyses of a repository room-and-pillar configuration, heated for one year by a waste container, were performed using three sets of salt properties. Qualitative comparisons between computer predictions and the rock mechanics results from Project Salt Vault were made. Max floor uplifts of 2.7 in. are predicted. A slight roof rise is predicted, whereas a sag was observed. The two-dimensional viscoelastic code was modified to include large displacement effects; results were obtained for two creep rates. The qualitative agreement between measured and predicted behavior of a typical repository room is encouraging. (DLC)

55909 (ORNL/SUB—3706/4) **Elastic solutions for selected circular-symmetric problems as applied to the design of the waste-container sleeve. Technical memorandum report RSI-0007.** Gnirk, P.F. (RE/SPEC, Inc., Rapid City, S.Dak. (USA)). 31 Sep 1973. Contract W-7405-ENG-26-SUB-3706. 17p. Dep. NTIS, PC A02/MF A01.

A number of finite-element models were developed for representing a vertical section through a circular-symmetric room-and-pillar configuration. Elastic solutions were developed and used to assess the relative accuracy of the finite-element analyses. The following situations were considered: stress free; containing an internal hollow cylinder; containing an internal solid cylinder; and fixed radially. (DLC)

55910 (ORNL/SUB—3706/6) **Thermoelastic analysis of waste-container sleeve: I. Initial estimates of loading on the sleeve. Technical memorandum report (RSI-0010).** Pariseau, W.G. (RE/SPEC, Inc., Rapid City, S.Dak. (USA)). 9 May 1974. Contract W-7405-ENG-26-7405-26-3706. 18p. Dep. NTIS, PC A02/MF A01.

Waste-container sleeve loading estimates of approximately 3300 psi were obtained from an axially-symmetric, thermoelastic/plastic, finite-element analysis of the SALT-4/T model over a simulated 10-year heating. Local failures of salt adjacent to the sleeve and in the vicinity of the excavated room are not observed; the model remains elastic throughout the excavation and heating periods. A reduced strength analysis indicates that a salt safety factor of approximately two is present. Actual waste-container sleeve loading will be highly dependent upon details of heat transfer to the adjacent salt, which in turn is directly dependent upon the geometry and installation of the proposed sleeve and container. In addition, material properties of the container/sleeve arrangement and the salt must be known for an accurate assessment of container design adequacy. It is therefore recommended that the analysis be pursued in additional detail sufficient for the specification of an efficient container and installation design.

55911 (ORNL/SUB—4269/2) **Thermoelastic/plastic analysis of waste-container sleeve: III. Influence of salt strength on sleeve loading. Technical memorandum report (RSI-0018).** Pariseau, W.G. (RE/SPEC, Inc., Rapid City, S.Dak. (USA)). 21 Mar 1975. Contract W-7405-ENG-26. 23p. Dep. NTIS, PC A02/MF A01.

Three combinations of salt tensile, compressive and shear strength in linear and nonlinear yield conditions used in the axially symmetric, large displacement thermoelastic/plastic waste-container/sleeve loading estimates show no influence on the analysis. The salt remains elastic throughout the excavation and subsequent 10 year heating period. Tensile stresses are not observed, tensile strength is thus not important to the analysis even at 10 percent of the compressive strength value. Although strictly applicable only to the conditions of the analyses reported here, the capability for incorporating arbitrary strength combinations in linear or non-linear yield conditions is demonstrated. Computer plots of principal stresses and displacement fields at various stages of the excavation and heating simulation aid in the visualization of repository concept mechanics and show the possible need for additional mesh refinement for more precise stress information.

55912 (ORNL/SUB—4269/3) **Thermoelastic/plastic analysis of waste-container sleeve: IV. Air gap influence on hole closure. Technical memorandum report (RSI-0019).** Pariseau, W.G. (RE/SPEC, Inc., Rapid City, S.Dak. (USA)). 21 Mar 1975. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

A thermoelastic/plastic finite element analysis of the influence of an air-gap on hole closure about a waste-container/sleeve assembly emplaced in a typical repository room (SALT/4T Model) indicates that hole closure would be of the order of hundredths of an inch. Acceptable air-gap width is thus governed by the hole size required for emplacement efficiency. A refined mesh analysis and laboratory testing is suggested in order to further explore the possibility of eliminating the engineering necessity of the sleeve.

55913 (ORNL/SUB—4269/4) **Thermo/viscoelastic analysis of the waste-container sleeve: I. Time-dependent salt loading on the sleeve and closure of the drillhole. Technical memorandum report RSI-0020.** Callahan, G.D.; Ratigan, J.L. (RE/SPEC, Inc., Rapid City, S.Dak. (USA)). 31 Oct 1975. Contract W-7405-ENG-26-SUB-4269. 47p. Dep. NTIS, PC A03/MF A01.

The thermo/viscoelastic analyses predicts a maximum drillhole surface pressure of approximately 3,000 psi after one-half year

of heating, assuming the drillhole surface is fixed against radial displacement. With the drillhole surface free to displace radially, the radial displacement is observed to be about 1.5 inches after twenty-five years of heating, for a total drillhole closure of 3.0 inches. In this particular case, with the centerline of the pillar being a line of symmetry, the material expansion upon heating forces the salt upward and into the room and drillhole areas. (20 figures)

55914 (ORNL/SUB—4269/11) **Design aspects of the alpha repository: IV. Structural analysis of excavation geometries. Technical memorandum report RSI-0030.** Ratigan, J.L.; Fossum, A.F.; Pariseau, W.G. (RE/SPEC, Inc., Rapid City, S.Dak. (USA)). 30 Jun 1975. Contract W-7405-ENG-26-SUB-4269/11. 56p. Dep. NTIS, PC A04/MF A01.

The primary objective of the work effort presented in this report was to provide preliminary estimates of various facets of the structural stability of typical room-and-pillar geometries in the three candidate horizons of the proposed New Mexico site of the Alpha repository. In addition to the determination of the structural integrity of the excavation, a supplementary objective of the work effort was to analyze the macroscopic behavior experienced by the room and pillar geometries with the introduction of a large number of holes drilled in the room floor for the emplacement of canisters containing radioactive waste, along with the local structural behavior of the drill holes. Specifically, the analyses of these aforementioned configurations consisted of elastic finite element modeling of two different room-and-pillar geometries in each of the three candidate horizons. Each of those six models inherently contained the macroscopic "stiffness" of the proposed drill hole pattern in an effort to determine global pillar behavior. In addition to the room and pillar modeling effort, finite element models of the drill hole patterns were developed for each of the two room sizes and subsequently analyzed in each of the candidate horizons. These drill hole models assumed an "in-line" hole pattern. However, the "off-set" hole pattern was also analyzed and is presented in this report. In conjunction with the finite element analysis of the particular geometrical configurations discussed above, an analysis of roof behavior and rock bolting requirements was undertaken and is also presented.

55915 (SAND—77-0274) **Waste Isolation Pilot Plant (WIPP) conceptual design report. Part I: executive summary. Part II: facilities and system.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1977. Contract EY-76-C-04-0789. 302p. Dep. NTIS, PC A13/MF A01.

The pilot plant is developed for ERDA low-level contact-handled transuranic waste, ERDA remote-handled intermediate-level transuranic waste, and for high-level waste experiments. All wastes placed in the WIPP arrive at the site processed and packaged; no waste processing is done at the WIPP. All wastes placed into the WIPP are retrievable. The proposed site for WIPP lies 26 miles east of Carlsbad, New Mexico. This document includes the executive summary and a detailed description of the facilities and systems. (DLC)

55916 (SRO-TWM—77-1) **Integrated radioactive defense waste management plan.** (Energy Research and Development Administration, Aiken, S.C. (USA). Savannah River Operations Office). Jul 1977. Contract EY-76-C-09-0001. 317p. Dep. NTIS, PC A14/MF A01.

The plan for controlling the releases of radioactivity and ensuring the safe storage of radioactive wastes generated by past, present, and future operation of the Savannah River Plant (SRP) is presented. The waste was categorized as solid, liquid, and gaseous, and the different waste management operations are categorized as treatment, storage, and release operations. Following a summary of the environmental effects of SRP emissions, the document includes in succession (1) a description of processes that generate wastes, (2) a description of the various waste treatment techniques, (3) a description of the waste holding facilities, and (4) a description of the plant's waste storage facilities. (LK)

55917 (Y/OWI/SUB—76/7253/1) **Proposed outline for a safety analysis report for a radioactive waste repository.** (Battelle Columbus Labs., Ohio (USA)). May 1977. Contract W-7405-ENG-26-7253. 120p. Dep. NTIS, PC A06/MF A01.

This report contains a proposed annotated outline for the Safety Analysis Report (SAR) for a national waste disposal facility. The outline is styled after the form described by NRC for other nuclear fuel cycle facilities. Chapters 4, 5, and 6 describe various aspects of the physical design and operation of the facility. These chapters are based on the conceptual design of a facility in a geologic deposit of bedded salt for the disposal of all transuranic wastes from the full recycle of fuel for commercial light water power reactors. Chapters 7, 8, 9, and 10 relate to on-site waste disposal and various aspects of the safe operation of the facility. This report also contains a discussion of the effect on the SAR of some changes in the waste products which may be considered for disposal, discussions of general safety problems, and recommendation for further research and development. (DLC)

55918 (Y/OWI/SUB—4496/2) **Geologic feasibility of talc and serpentinite bodies from the Appalachian Mountain region of eastern United States with regard to siting of radioactive-waste repositories. Part I. Additional conclusions relating to ultramafic rocks. Part II. Field investigations of talc and serpentinite deposits. Supplementary report.** Wenner, D.B. (Georgia Univ., Athens (USA). Dept. of Geology). Jan 1976. Contract W-7405-ENG-26. 30p. Dep. NTIS, PC A03/MF A01.

Ultramafic rocks and serpentinites appear to have many favorable features that make them worthy of further consideration. Such rock types are widely distributed in this country and display wide variations in their physical properties, based largely on the degree of serpentinization and mineral content. For example, serpentinite has certain self-sealing and flowage characteristics that render it impermeable at depth, whereas unserpentinized ultramafic rocks are structurally very rigid and strong. Another favorable property of ultramafic rocks is the relatively low thermal expansion coefficient. Talc also has some favorable features and characteristics such as a high thermal stability and a low porosity and permeability. This present study has verified that very little ground water influx occurs in talcose rocks except in large fault zones. A major drawback for the usage of talc for containment of radioactive wastes is due to the relatively small sizes of most bodies. However, some of the large talc-carbonate units in the Missisquoi Valley Region of Vermont has potential. Consideration should also be given to other crystalline rocks as well, particularly schists, since they commonly contain micaceous materials which have similar properties to talc and serpentine. In considering various types of rocks for containment of radioactive wastes, the important properties are thermal conductivities, thermal expansion coefficients, thermal stabilities, and how high radiation fluxes affect these properties. (DLC)

55919 (Y/OWI/TM—8/1) **Summary of geologic review group meeting, January 20—21, 1977.** Frye, J.C.; Crawford, J.H.; Davis, S.N.; Donath, F.A.; Gloyna, E.F.; Krauskopf, K.B. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Office of Waste Isolation). 7 Mar 1977. Contract W-7405-ENG-26. 14p. Dep. NTIS, PC A02/MF A01.

The Office of Waste Isolation program was reviewed. Topics involving program management and geologic aspects of radioactive waste isolation were discussed.

55920 (Y/OWI/TM—9) **Conceptual design criteria for facilities for geologic disposal of radioactive wastes in salt formations.** (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). Jan 1977. Contract W-7405-ENG-26. 46p. (X-OE—17). Dep. NTIS, PC A03/MF A01.

The facility design requirements and criteria discussed are: general codes, standards, specifications, and regulations; site criteria; land improvements criteria, low-level waste facility criteria; canistered waste facility criteria; support facilities criteria; and utilities and services criteria. (LK)

55921 **Leaching of solidified radioactive waste.** Anders, O.U.; Altschuler, S.J. (Dow Chemical Co., Midland, MI). *Trans. Am. Nucl. Soc.;* **26**: 142-143(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55922 **Calculations of radioactivity release due to leaching of vitrified high-level waste.** Ewest, E. (Hahn-Meitner Inst., Berlin). *Trans. Am. Nucl. Soc.;* **26**: 274-275(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55923 **Contributions to the risk analysis of a repository for high-level radioactive wastes in geologic salt formations.** Proske, R. (Gesellschaft fuer Strahlen -und Umweltforschung mbH, Munich). *Trans. Am. Nucl. Soc.;* **26**: 277-278(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55924 **West Valley waste burial area problems correlated to operating practices.** Robertson, C.G. (New York State Energy Research and Development Authority, NY). *Trans. Am. Nucl. Soc.;* **26**: 290-291(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55925 **Waste trench cap study of remedial work for West Valley.** Robertson, C.G. (New York State Energy Research and Development Authority, NY); Berlin, R.E. *Trans. Am. Nucl. Soc.;* **26**: 291(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55926 Performance calculations of fast reactor actinide recycle as a waste management alternative. Murphy, D.J. Jr.; Farr, W.M.; Ganapol, B.D. (Univ. of Arizonia, Tucson). *Trans. Am. Nucl. Soc.;* **26**: 294-295(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55927 Oceanic distributions of radionuclides from nuclear weapons testing. Bowen, V.T. (Woods Hole Oceanographic Inst., MA). *Trans. Am. Nucl. Soc.;* **26**: 297(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55928 U.S. seabed high-level radioactive waste disposal feasibility study. Talbert, D.M.; Anderson, D.R. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.;* **26**: 297-298(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55929 Prospect of international cooperation on high-level-waste disposal on the ocean floor. Nielsen, S.O.; Bendig, D.J. (Symplexor Engineering Consultants, Inc., Holte, Denmark). *Trans. Am. Nucl. Soc.;* **26**: 298-299(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55930 Oceanographic processes and the ultimate disposal of high-level radioactive waste. Hollister, C.D.; Rhines, P.B. (Woods Hole Oceanographic Inst., MA). *Trans. Am. Nucl. Soc.;* **26**: 299-301(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55931 Political and legal implications of radioactive waste disposal at sea. Deese, D.A. (Woods Hole Oceanographic Inst., MA). *Trans. Am. Nucl. Soc.;* **26**: 301-302(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 55916, 55917, 55921, 55922, 55923, 55951

55932 (DPST—76-254) Status report: borehole monitoring of radioactive waste trenches 1965—1974. Fenimore, J.W. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 15 Mar 1977. Contract EY-76-C-09-0001. 15p. Dep. NTIS, PC A02/MF A01.

Ten years of radiation profile measurements in dry wells through waste emplacements in the Savannah River Plant burial ground show that: Leaching and downward movement of leached material is not extensive. The bulk of radionuclides buried with waste remains in place after burial. Radiation intensities at half the monitored locations have decreased considerably in 10 years. The other half, major radiation peaks are still giving off scale readings on the Thyac monitor. (12 figs.) (DLC)

55933 (ERDA—77-75) Light water reactor fuel reprocessing and recycling. (Energy Research and Development Administration, Washington, D.C. (USA)). Jul 1977. vp. Dep. NTIS, PC A22/MF A01.

This document was originally intended to provide the basis for an environmental impact statement to assist ERDA in making decisions with respect to possible LWR fuel reprocessing and recycling programs. Since the Administration has recently made a decision to indefinitely defer reprocessing, this environmental impact statement is no longer needed. Nevertheless, this document is issued as a report to assist the public in its consideration of nuclear power issues. The statement compares the various alternatives for the LWR fuel cycle. Costs and environmental effects are compared. Safeguards for plutonium from sabotage and theft are analyzed. (DLC)

55934 (INIS-mf—3272) Ranger uranium environmental enquiry. Final submission by the Australian Atomic Energy Commission. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jul 1976. 111p. Dep. NTIS (US Sales Only), PC A06/MF A01.

The submission is divided into three sections. Section A considers the international implications of the development of uranium resources including economic and resource aspects and environmental and social aspects. Section B outlines the government's position on export controls over uranium and its effect on the introduction of nuclear power in Australia. Section C describes the licensing and regulatory functions that would be needed to monitor the environmental and health aspects of the Ranger project.

55935 (LA—6839-MS) Geology and hydrology in the vicinity of the inactive uranium mill tailings pile, Ambrosia Lake, New Mexico. Purtymun, W.D.; Wienke, C.L.; Dreesen, D.R. (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1977. Contract W-7405-ENG-36. 36p. Dep. NTIS, PC A03/MF A01.

A study was made of the geology and hydrology of the immediate area around a uranium mill at Ambrosia Lake, New Mexico. The mill was in operation from June 1958 through April 1963 and produced 2.7 x 10^9 kg of tailings. The possible environmental consequences of this inactive tailings pile must first be delineated so that stabilization needs and future stabilization success can be properly assessed. The Ambrosia Lake area is underlain by over 1000 m of alternating shales, siltstones, and sandstones that dip gently to the northeast into the San Juan Basin. Water-bearing sandstones make up less than 25 percent of this sedimentary section. Water quality in the sandstones is fair to poor, with total dissolved solids ranging from 500 to 2000 mg/l. The present total volume of tailings is estimated at 1.5 x 10^6 m^3 and ranges in thickness from about 1 to 10 m. The tailings pile is underlain by the Mancos shale which dips to the northeast. The shale is about 120 m thick with three interbedded silty sandstones that are about 9 m in thickness. One of these sandstones outcrops beneath the western part of the pile; the eastern part of the pile is underlain by shale. Ground water in the shales and sandstones beneath the pile is recharged by runoff north of the pile and from three ponds located north, northeast, and east of the pile. The movement of water in shale and sandstones is to the southwest. Secondary recharge to the water in the shales and sandstone is from the basin within the tailings pile. Water in the southeast part of the tailings basin is forming a ground water mound above the underlying sediments. The major transport mechanisms of tailings and possible contaminants from the pile include wind erosion, surface water runoff, movement of ground water beneath the pile, and gaseous diffusion from the pile (radon).

55936 Cost of controlling inorganic chemical releases from LWR fuel fabrication plants. Pechin, W.H.; Blanco, R.E.; Dahlman, R.C.; Finney, B.C.; Lindauer, R.B.; Witherspoon, J.P. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 106-108(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55937 Anticipated chemical emissions from a large fuel reprocessing plant. Darr, D.G.; Murbach, E.W. (Allied-General Nuclear Services, Barnwell, SC). *Trans. Am. Nucl. Soc.;* **26**: 108-109(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55938 Toxicity of some of the organic emissions identified in the effluents from reprocessing nuclear fuel. Freudenthal, R.I. (Battelle Columbus Labs., Columbus, OH). *Trans. Am. Nucl. Soc.;* **26**: 109(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55939 Social and environmental assessment of coal and uranium in the Western United States. Sandquist, G.M. (Univ. of Utah, Salt Lake City); Sgamma, R.B.; Rogers, V.C. (Ford, Bacon, and Davis Utah Inc., Salt Lake City). *Trans. Am. Nucl. Soc.;* **26**: 140-142(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55940 Measurements of surface radon fluxes from uranium mill tailings. Macbeth, P.J. (Ford, Bacon, and Davis Utah Inc., Salt Lake City); Rogers, V.C.; Chater, A.; Sandquist, G.M.; Jensen, C.M. *Trans. Am. Nucl. Soc.;* **26**: 143(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 55861, 55904, 55922, 55923, 55940, 56588, 56598, 56599, 56938

55941 Risk estimation, evaluation, and management. Otway, H.J. (International Atomic Energy Agency, Vienna); Linnerooth, J.; Niehaus, F. *Trans. Am. Nucl. Soc.;* **26**: 263-264(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55942 Perspectives on risk assessment for radioactive waste management systems. Bartlett, J.W. (Battelle Pacific Northwest Lab., Richland, WA); Goranson, R.B. *Trans. Am. Nucl. Soc.;* **26**: 264-265(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55943 Risk assessment method for nuclear fuel cycle operations. Pelto, P.J.; Winegardner, W.K. (Battelle Pacific Northwest Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* **26**: 266-267(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55944 Risk analysis of radioactive waste management systems in Germany. Wingender, H.J. (NUKEM GmbH, Hanau, Ger.). *Trans. Am. Nucl. Soc.;* **26**: 267-268(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55945 Preliminary accident radiological risk assessment of a large commercial MOX fuel fabrication plant. Erdmann, R.C.; Fullwood, R.R.; Ritzman, R.L. (Science Applications, Inc., Palo Alto, CA). *Trans. Am. Nucl. Soc.;* **26**: 268(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55946 Risk comparison of alternatives of the back end of the fuel cycle at a pre-project stage. Linder, P. (AB Atomergi, Nykoeping, Sweden); Brandberg, S. *Trans. Am. Nucl. Soc.;* **26**: 268-269(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55947 Contributions to the risk evaluation of a high-level waste solidification plant. Bruecher, H. (Kernforschungsanlage Juelich GmbH, Juelich, Ger.). *Trans. Am. Nucl. Soc.;* **26**: 270-271(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55948 Preliminary risk analysis of the transportation of nuclear waste. Fullwood, R.R. (Science Applications, Inc., Palo Alto, CA); Straker, E.A.; Aron, W. *Trans. Am. Nucl. Soc.;* **26**: 271-272(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55949 Transportation of vitrified high-level radioactive waste by rail: fault tree analysis and accidental release. Schneider, K. (Transnuklear GmbH, Hanau, Ger.). *Trans. Am. Nucl. Soc.;* **26**: 272-273(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55950 Risk analysis of the road transport of radioactive waste in the Netherlands. Van Otterloo, R.W. (N. V. KEMA, Arnhem, Netherlands). *Trans. Am. Nucl. Soc.;* **26**: 273-274(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55951 Long-term risk assessment of radioactive waste disposal in geological formations. Girardi, F.; Bertozzi, G.; D'Alessandro, M. (Joint Research Center, Ispra, Italy). *Trans. Am. Nucl. Soc.;* **26**: 275-277(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55952 Relative hazard of nuclear wastes and naturally occurring toxic minerals. Tonnessen, K.A.; Cohen, J.J. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.;* **26**: 291-293(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55953 Criteria for assessing radioactive waste management schemes. Perret, F.L. (Institut Europeen d'Administration des Affaires, Fontainebleu, France); Yadigaroglu, G.; West, C. *Trans. Am. Nucl. Soc.;* **26**: 295-296(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

REGULATIONS

REFER ALSO TO CITATION(S) 56589, 56603

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 55873, 55883, 55887, 56548, 57831

55954 (CONF-7605150—1) **Is plutonium really necessary.** Taylor, V. (Pan Heuristics, Los Angeles, Calif. (USA)). 9 Sep 1976. 43p. Dep. NTIS, PC A03/MF A01.

From Conference on the spread of nuclear technology; Windsor, United Kingdom of Great Britain and Northern Ireland (UK) (26 May 1976).

Not all activities associated with nuclear power contribute equally to proliferation potential, but some fuel-cycle activities (i.e., reprocessing) are considered too dangerous to be permitted in nonweapons countries. This paper assesses the feasibility of keeping Pu out of the nuclear fuel cycle. It is pointed out that there is no technical necessity of using Pu as nuclear fuel so long as ^{233}U is available. Analysis of the economics of recycling spent fuel products in LWRs in the U.S. shows that the net economic benefit of recycle is uncertain and might even be negative; it will have an insignificant effect on the cost of nuclear power. It is argued that reprocessing of spent fuel be deferred until recycle in LWRs can be shown to yield economic benefits sufficiently large to compensate for the risks, or the viability of the breeder as an important commercial source of power has been demonstrated. According to the low estimate of U requirements, the world would have enough U resources well into the 21st century, although if the high estimate is used, the world would exhaust its reserves by the year 2000. Evidence indicates that nuclear power will grow more slowly than the forecasts of the nuclear advocates. Thus, there may be no need for an early decision to undertake recycling, and research on breeder development can proceed at a slower rate. (DLC)

55955 (MLM—2429) **Progress report for the Division of Safeguards and Security: July—December 1976.** Ratay, R.P. (ed.). (Mound Lab., Miamisburg, Ohio (USA)). 29 Jun 1977. Contract EY-76-C-04-0053. 16p. Dep. NTIS, PC A02/MF A01.

In the work on prediction of calorimeter equilibrium, a newly derived single-exponential prediction equation has been shown to yield results equal to those from previously reported work, but allows for more versatility in the instrumentation selection. A single-precision rather than a double-precision calculator is all that is required to predict reliable equilibrium values using this new equation. A double-exponential prediction equation has also been derived and tested using simulated data. Engineering refinements have been incorporated in the Automated Plutonium Assay System (APAS) to provide for improvements in the gamma-ray spectroscopy system and the container pickup device. In addition, evaluation tests on the assay instrumentation have been conducted. Calorimeter tests indicate that values within 1 percent of equilibrium can be obtained in 7 min. The Half-Life Evaluation Committee has completed measurements of the half-life of ^{239}Pu. Preliminary results show that measurements by alpha and gamma counting, by mass spectrometry and by calorimetry agree sufficiently well that a recommended value with a relative standard deviation of +-0.1 percent will be reported. Papers describing these measurements are being prepared for journal publication. The committee concurs with the recent recommendation by Argonne National Laboratory representatives that the value 87.74 +- 0.04 yr be adopted for the half-life of ^{238}Pu. Calorimetric assay has been used to prepare plutonium reference standards for use in verifying other NDA measurement systems. The reference samples contained plutonium oxide, nitride, and/or metal mixed with natural, depleted, and/or enriched uranium oxide, nitride, and/or metal. Eight samples have been certified, with plutonium uncertainties of less than 1 percent. They cover the weight range from 4.3 to 141.2 g of plutonium.

55956 (NUREG—0290(Vol.1)) **Study of nuclear material accounting. Final report, July 1, 1976—April 1, 1977.** Siri, W.E.; Ruderman, H.; Winsen, J.; Dresher, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1977. Contract W-7405-ENG-48. 126p. Dep. NTIS, PC A07/MF A01.

The basic result of this study was to affirm the utility of material accounting as a tool for safeguards purposes. Periodic inventories and proper interpretation of material unaccounted for

(MUF) can be an effective procedure for estimating diversion and taking necessary follow-on action. We have developed a new approach in this study based upon the theory of games that eliminates many of the deficiencies of the classical statistical hypothesis testing approach. This new approach explicitly considers a malevolent Diverter as a basic ingredient of the analysis. This permits a different and more effective interpretation of MUF for safeguards purposes. At the present time MUF interpretation for major nuclear facilities cannot adequately support statements about diversion. Consequently NRC does not rely solely on MUF analysis for such statements. Diversion statements now are primarily based upon other safeguards systems and information. However, the game theoretic approach can make the periodic inventory-MUF concept work better for safeguards. With its use, MUF data by itself can be useful in directly interpreting possible unauthorized diversion of special nuclear material.

55957 (NUREG—0290(Vol.2)) **Study of nuclear material accounting. Final report, July 1, 1976—April 1, 1977.** Siri, W.E.; Donelson, S.; Glancy, J.; Gozani, T.; Hartenau, B.; Maly, J.; Wimpey, F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1977. Contract W-7405-ENG-48. vp. Dep. NTIS, PC A11/MF A01.

The following topics are discussed: improved detection sensitivity for periodic accounting; simulation of MUF and LEMUF; and vulnerability of nuclear material accounting to tampering. (LK)

55958 (NUREG—0290(Vol.3)) **Study of nuclear material accounting. Final report, July 1, 1976—April 1, 1977.** Siri, W.E.; Gozani, T.; Maly, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1977. Contract W-7405-ENG-48. 134p. Dep. NTIS, PC A07/MF A01.

The following topics are discussed: hierarchy of accountability measurements; survey of analytical methods; accuracies of analytical methods for material accountability; and vulnerability of accountability measurements. (LK)

55959 (NUREG—0350(Vol.1)(No.1)) **Report on strategic special nuclear material inventory differences.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Material Safety and Safeguards). Jul 1977. 67p. NTIS $4.50.

The information covers the operation of major licensed nuclear fuel manufacturers and research laboratories processing significant quantities of strategic SNM (5 kg ^{235}U, 2 kg Pu or ^{233}U) between Jan. 1, 1968 and Sept. 30, 1976. Fuel manufactured for commercial light water power reactors is not covered. The data presented are inventory differences (MUFs). (DLC)

55960 (SAND—77-0191) **Automatic duress alarms through physiological response monitoring.** Roehrig, S.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jul 1977. Contract EY-76-C-04-0789. 41p. Dep. NTIS, PC A03/MF A01.

Physiological response monitoring under controlled conditions can provide an effective means for passively determining if the wearer is under moderate to severe stresses. By monitoring the heart rate (HR) and galvanic skin response (GSR) of an individual, it is possible to detect in real time the increase in heart rate and GSR levels due to physiological reactions to mental duress. With existing physiological monitoring equipment, however, the work load of the wearer must be well defined since it is impossible, without additional data, to distinguish mental duress responses from those resulting from moderate physical exertion. Similarly, environmental conditions should be constrained within set limits to avoid masking increases in GSR levels due to metntal stress from those associated with increased perspiration. These constraints should not prove overly restrictive and would allow an integrated security system utilizing physiological monitoring equipment to provide an effective real time, automated early warning system for detection of mental duress or death of the wearer.

55961 (SAND—77-0890C) **Safeguards system design methodology.** Cravens, M.N.; Winblad, A.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 20p. (CONF-770656—13). Dep. NTIS, PC A02/MF A01.

From Annual meeting of the Institute of Nuclear Materials Management; Washington, District of Columbia, United States of America (USA) (29 Jun 1977).

Sandia Laboratories is developing methods for the design of physical protection systems to safeguard special nuclear material and vital equipment at fixed sites. One method is outlined and illustrated with simplified examples drawn from current programs. The use of an adversary sequence diagram as an analysis tool is discussed.

55962 (SAND—77-0980C) **Surveillance and containment instrumentation international safeguards.** Ney, J.F.; Campbell, J.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 16p. (CONF-770656—9). MF A01.

From Annual meeting of the Institute of Nuclear Materials Management; Washington, District of Columbia, United States of America (USA) (29 Jun 1977).

The objective of IAEA safeguards is the timely detection of diversion of significant quantities of nuclear material from peaceful activities to the manufacture of nuclear explosive devices or for purposes unknown, and deterrence of such diversion by risk of early detection. Techniques utilized to provide this detection capability include material accountancy, containment, and surveillance. Sandia Laboratories has developed a number of unattended, tamper indicating instruments that can be used as part of a containment and surveillance system. Three such devices are: a secure surveillance camera, an irradiated fuel bundle counter, and a self-monitoring seal.

55963 (SAND—77-0999) **Physical protection of nuclear facilities. Quarterly progress report, January—March 1977.** Chapman, L.D. (ed.). (Sandia Labs., Albuquerque, N.Mex. (USA)). Jul 1977. Contract EY-76-C-04-0789. 32p. Dep. NTIS, PC A03/MF A01.

The physical protection of nuclear facilities program consists of four major areas—evaluation methodology development, path generation/selection methodology, facility characterization, and component functional performance characterization. Activities in each of these areas for the second quarter of FY 77 are summarized.

55964 (SAND—77-8249) **Evaluation of safeguards systems for nuclear material in transit: the development of the program plan. Winter 1977 quarterly report.** Rinne, R.L. (Sandia Labs., Livermore, Calif. (USA)). Jul 1977. Contract EY-76-C-04-0789. 30p. Dep. NTIS, PC A03/MF A01.

The program plan is presented, together with highlights of current activities in several sub-task areas: convoy configuration analysis, communications analysis, response force analysis, and conflict analysis. 13 figures.

55965 (TREE—1145) **Uranium accountability for ATR fuel fabrication. Part I. A description of the existing system.** Dolan, C.A.; Nieschmidt, E.B.; Vegors, S.H. Jr.; Wagner, E.P. Jr. (EG and G Idaho, Inc., Idaho Falls (USA)). Jun 1977. Contract EY-76-C-07-1570. vp. Dep. NTIS, PC A05/MF A01.

An evaluation of the materials accountability program at the Atomics International fuel fabrication facility in Canoga Park, California, with regard to the fabrication of highly enriched uranium fuel for the Advanced Test Reactor is presented. An analysis is given of the existing standards program, the existing measurements program and the existing statistical analysis procedures. In addition a short discussion is given of our evaluation of the safeguards procedures at Atomics International together with suggestions for possible modifications and improvements. Appendices of this report contain a rather complete description of the Atomics International plant and the flow of highly enriched uranium through the plant as well as the principal documents used for material accountability records.

55966 (UCRL—79214) **Material control assessment procedure.** Adams, R.W.; Spogen, L.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1977. Contract W-7405-ENG-48. 9p. (CONF-770656—14). Dep. NTIS, PC A02/MF A01.

From Annual meeting of the Institute of Nuclear Materials Management; Washington, District of Columbia, United States of America (USA) (29 Jun 1977).

The material control system assessment procedure being developed by the Lawrence Livermore Laboratory for the U.S. Nuclear Regulatory Commission is reviewed. It consists of five major sections: Target Identification, Adversary Sequence and Simuli Generation, Material Control System Response Determination, Safeguard System Outcome Determination, and Safequard System Utility Determination. When adopted, this procedure will minimize safeguards licensing problems by providing compatibility with future performance based regulations, explicit evaluation rules and requirements, well-defined trade-off structures, and user-oriented and systematic evaluation and design tools.

55967 **Unique field-readable Type E security seal.** McCormick, N.J. (Univ. of Washington, Seattle). *Trans. Am. Nucl. Soc.*; **26**: 303(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

ADMINISTRATIVE AND REGULATORY

REFER ALSO TO CITATION(S) 55860

FUSION FUELS

PROCESSING

55968 (UCRL—52262) **Methane formation in tritium gas exposed to stainless steel.** Morris, G.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Mar 1977. Contract W-7405-ENG-48. 14p. Dep. NTIS, PC A02/MF A01.

Tests were performed to determine the effect cleanliness of a surface exposed to tritium gas had on methane formation. These tests performed on 304 stainless steel vessels, cleaned in various ways, showed that the methane formation was reduced by the use of various cleaning procedures.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

REFER ALSO TO CITATION(S) 57253

55969 (MLM—2391) **Survey of large-scale isotope applications: nuclear technology field.** Dewitt, R. (Mound Lab., Miamisburg, Ohio (USA)). 21 Jan 1977. Contract EY-76-C-04-0053. 20p. Dep. NTIS, PC A02/MF A01.

A preliminary literature survey of potential large-scale isotope applications was made according to topical fields; i.e., nuclear, biological, medical, environmental, agricultural, geological, and industrial. Other than the possible expansion of established large-scale isotope applications such as uranium, boron, lithium, and hydrogen, no new immediate isotope usage appears to be developing. Over the long term a change in emphasis for isotope applications was identified which appears to be more responsive to societal concerns for health, the environment, and the conservation of materials and energy. For gram-scale applications, a variety of isotopes may be required for use as nonradioactive "activable" tracers. A more detailed survey of the nuclear field identified a potential need for large amounts (tons) of special isotopic materials for advanced reactor components and structures. At this need for special materials and the development of efficient separation methods progresses, the utilization of isotopes from nuclear wastes for beneficial uses should also progress.

PHYSICAL ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 57799

RADIATION SOURCES

DESIGN AND FABRICATION

REFER ALSO TO CITATION(S) 57090

55970 (SAND—77-6013) **Two-electrode pulsed x-ray tube.** Zelenskii, K.F.; Troshkin, I.A.; Tsukerman, V.A. 1961. Translation by P. Newman of Russian Patent 734,782/26. 6p.

Two-electrode, pulsed, x-ray tubes using the phenomenon of breakdown in high vacuum to generate short bursts of x-ray radiation are known, in which the anode is shaped like a needle, they are not very useful since they do not protect the insulator from deposition from metal vapors and have insufficient x-ray radiation output. A tube is proposed in which these deficiencies are eliminated by the fact that the needle-shaped anode is passed inside a hollow, cylindrical cathode.

OTHER INDUSTRIAL USES

55971 **Pasteur v curie.** *Consult. Eng. (London);* **41**: No. 4, 43, 45(Apr 1977).

It is stressed that if sewage is to fulfill its potential as an agricultural fertilizer, rather than as fuel for an incinerator, it must be sterilized. Two different methods of achieving the necessary sterility including pasteurization and irradiation are reviewed.

ISOTOPIC POWER SUPPLIES

55972 **Functional and structural performances of radioisotope power sources for artificial heart.** Fumero, R.; Mambretti, C. (Politec di Milano, Italy). *Termotecnica (Milan);* **30**: No. 11, 558-567(Nov 1976). (In Italian).

This work studies the feasibility of using radioisotope heat sources as power generator for total cardiac prosthesis. The mutual interactions between the thermal accumulator dimensions used for functional regulation and the dimension of sources shielding to optimize the volume and weight of system are examined. Gamma and neutron doses are evaluated for various solutions of design, to get the greatest safety both for the patient and for the people living near him.

DESIGN AND FABRICATION

55973 (BMI-X—683) **Heat source component development program. Quarterly report for April—June 1977.** Foster, E.L. Jr. (comp.). (Battelle Columbus Labs., Ohio (USA)). Jul 1977. Contract W-7405-ENG-92-094. 63p. Dep. NTIS, PC A04/MF A01.

This is the third in a series of quarterly reports describing the results of several experimental programs being conducted at Battelle-Columbus to develop components for advanced radioisotope heat source applications. The heat sources will for the most part be used in advanced static and dynamic power conversion systems. The specific component development efforts which are described include: improved selective and nonselective vents for helium release from the fuel containment; an improved reentry member and an improved impact member, singly and combined. The unitized reentry-impact member (RIM) is under development to be used as a bifunctional ablator. The development of a unitized reentry-impact member (RIM) has been stopped and the efforts are being redirected to the evaluation of materials that could be used in the near term for the module housing of the General Purpose Heat Source (GPHS). This redirection will be particularly felt in the selection of (improved) materials for reentry analysis and in the experimental evaluation of materials in impact tests. Finally thermochemical supporting studies are reported.

55974 (DPST—77-128-6) **^{238}Pu fuel form processes. Savannah River Laboratory monthly report, June 1977.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1977. Contract EY-76-C-09-0001. 21p. Dep. NTIS, PC A02/MF A01.

Experimental process development activities for the MHW fuel form program have been temporarily reduced to increase effort in support of startup of the PuFF Facility and assistance in producing three prototypic MHW spheres. Preproduction operations for fabricating the three prototypic spheres are summarized; centerline process conditions and expected product characteristics are given. Particle size and morphology of samples from several batches of H-Area B-Line $^{238}PuO_2$ were studied as a basis for selecting feed to fabricate the three prototypic spheres. Results indicate all batches meet requirements of acceptable feed material. Installation of major systems and equipment has been completed. Checkout of equipment and services continues.

HYDROGEN

REFER ALSO TO CITATION(S) 56089

PRODUCTION

REFER ALSO TO CITATION(S) 56027

ELECTROLYSIS

REFER ALSO TO CITATION(S) 56430

THERMOCHEMICAL PROCESSES

55975 **High temperature corrosion in the thermochemical hydrogen production from nuclear heat.** Coen-Porisini, F.; Imarisio, G. (Comm of the Eur Community, JRC, Ispra, Italy). *Rev. Int. Hautes Temp. Refract.;* **13**: No. 4, 250-261(1976).

Results are presented of extensive corrosion experiments undertaken to determine the corrosion behavior of some high-temperature materials used in hydrogen production by chemical decomposition of water by utilizing nuclear reactor process heat. The experiments included weight change measurements, optical and scanning electron microscopic examinations, and X-ray diffraction analysis of the corrosion products. The corrosive environments examined included: Hydrobromic acid, hydrochloric acid, ferric chloride, and hydriodic acid.

PROPERTIES

REFER ALSO TO CITATION(S) 57247

55976 Investigation of a turbulent free-jet flame with chemical unbalance. Oyegbesan, A.O.; Algermissen, J. (Univ Stuttgart, Ger). *Brennst.-Waerme-Kraft;* **29**: No. 3, 99-103(Mar 1977). (In German with English abstract).

The complex reaction and exchange processes in a flame of hydrogen and oxygen are analyzed numerically. From the description of the transport increased rates by local turbulent pulsations are derived four semi-empirical models. The field distributions of the flow velocity, the temperature and mass proportion of the various chemical components are described. The calculation shows that the various turbulence models for the flow field result in noticeably different profiles of the calculated field variables. 16 refs.

55977 Explosion limits of hydrogen-oxygen mixture as a stochastic phenomenon. Terao, K. (Yokohama Natl Univ, Jpn). *Jpn. J. Appl. Phys.;* **16**: No. 1, 29-38(Jan 1977).

The fluctuation in the induction period of ignition as well as the randomness of the ignition position in a hydrogen-oxygen mixture behind reflected shock waves has been statistically investigated. It is proved that ignition is a stochastic phenomenon by comparing the ignition probability of the mixture obtained from a histogram of the induction period and that obtained from a histogram of the ignition position. The explosion limits of the hydrogen-oxygen mixture, the so-called explosion peninsula, is explained by the stochastic theory in which the mixture has a certain constant ignition probability. 20 refs.

55978 Mechanism of the oxidation of hydrogen on platinum. Balovnev, Yu.A. *Russ. J. Phys. Chem. (Engl. Transl.);* **50**: No. 10, 1605-1606(Oct 1976).

Translated from Zh. Fiz. Khim.; 50: No. 10, 2686-2688(Oct 1976).

The rate constants for the oxidation of hydrogen on platinum under molecular gas flow conditions have been compared for systems with an excess of hydrogen and an excess of oxygen. A single mechanism for the oxidation of hydrogen on platinum is proposed on the basis of the invariance of the rate constant over the entire range of relative concentrations of the reactants.

55979 Shock compression of liquid hydrogen in various experimental geometries. Bordzilovskii, S.A.; Silvestrov, V.V.; Titov, V.M. (Inst of Hydrodyn, USSR Acad of Sci, Novosibirsk). *Acta Astronaut.;* **3**: No. 11-12, 1015-1032(1976).

In connection with the use of cryogenic liquids in high-speed gas dynamics and high-pressure physics, shock-wave processes in liquid hydrogen were investigated under plane, cylindrical, and hemispherical loading. The plane loading, which consisted of a multicyclic, nearly isentropic compression, resulted in a sequence of shock steps of decreasing amplitude, whose integrated action is equivalent to the isentropic compression of liquid hydrogen up to 500 kbar. The cylindrical loading was generated by detonating a high-explosive charge enclosing a cylindrical cavity along its axis that was filled with liquid hydrogen. Under these conditions, shock velocities up to 13.7 km/sec were recorded, and pressure in the shock-compressed hydrogen reached 90 kbar. Under hemispherical loading, an increase in the converging shock velocity from 6 to 20 km/sec was recorded. The final pressure reached 210 kbar, and the total specific energy exceeded 200 kJ/g. During the release of the shock-compressed hydrogen into air at 0.1 torr, shock waves with velocities exceeding 50 km/sec were obtained. 21 refs.

OTHER SYNTHETIC AND NATURAL FUELS

REFER ALSO TO CITATION(S) 55658, 56089, 56926, 56927

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 55586, 55808, 56194

PROPERTIES

55980 Influence of additives obtained from alkaline metals on soot concentration of hydrocarbon diffusive-laminar flames. Marinescu, M.; Danescu, Al. (Polytech Inst of Bucharest, Rom). *Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.;* **21**: No. 4, 617-622(1976). (In French).

The paper considers the effect of concentration of free electric charges in the reaction zone, due to thermal ionization of alkaline metals, on soot concentration in diffusive-laminar hydrocarbon flames. It is shown that soot concentration depends closely on the density of the free electric charges in the reaction zone. Soot particles are charged positively. this electric charge results mainly from the concentration of carbon around positive ions which diffuse in the reaction zones. Introduction of a chemical element with a low ionization potential (usually alkali metals) has simultaneously two contradictory effects: an inhibiting effect as a result of partial consumption of water molecules, and a stimulating effect as a result of an increase in the concentration of positive electric charges.

PREPARATION

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 55594

55981 (BNL—22785) **Synthetic carbonaceous fuels and feedstocks from oxides of carbon and nuclear power.** Steinberg, M. (Brookhaven National Lab., Upton, N.Y. (USA)). Mar 1977. Contract EY-76-C-02-0016. 29p. (CONF-770804—4). Dep. NTIS, PC A03/MF A01.

From 12. intersociety energy conversion engineering conference; Washington, District of Columbia, United States of America (USA) (28 Aug 1977).

A study has been made on converting alternative sources of oxides of carbon (CO and CO_2) to synthetic methanol with nuclear power generated electrolytic hydrogen and oxygen. The sources of CO and CO_2 include (1) the oxygen blown blast furnace which produces CO as a by-product from hot metal production, (2) the steam calcination of limestone which produces CO_2 as a by-product of the lime and cement industry, (3) fossil fuel power plant stack gas as a source of CO_2 and, (4) the atmosphere, from which CO_2 is recovered in a novel carbonate electrolytic cell. The recovered CO or CO_2 is catalytically combined with electrolytic H_2 to produce the synthetic fuels. In these systems, the conservation, efficiency, and environmental control of coal utilization is significantly improved. Blast furnace CO could supply up to 20 percent of the gasoline demand in the US at a 1985 cost of 56 to 60 cents/gallon, breaking even with $19/Bbl imported oil. The CO_2 from steam calcination of limestone could supply about 9 percent of the gasoline demand and the recovered CO_2 from only 60 percent of the coal fired powered plants in the country could supply all of todays gasoline demand in the country (approximately 100 billion gallons/yr). The 1985 cost estimates for carbon dioxide based gasoline range from 68 cents/gallon for the highly concentrated calciner CO_2 feedstream to 83 cents/gallon for the very dilute atmospheric CO_2 feed, breaking even with $21 to $28/barrel oil for conventional gasoline. The dominating cost factor is the electrical power cost from the nuclear plant. The sharing of peaking and base load costs between the power and synthetic fuels consumers offers a cost and energy effective system.

55982 Manufacture of hydrocarbons. Lago, R.M. (to Mobil Oil Corp.). US Patent 4,025,572. 24 May 1977. Filed date 12 May 1976. 14p.

A catalytic process is provided for converting lower monohydric alcohols and their ethers, especially methanol and dimethyl ether, to a hydrocarbon mixture rich in C_2—C_3 olefins and mononuclear aromatics with high selectivity for para-xylene production by contact, under conversion conditions, with a catalyst bed comprising a major proportion of particle-form inert solid diluent having intermixed therewith a crystalline aluminosilicate zeolite characterized by (1) a crystallite size not greater than 0.5 micron, (2) a particle size less than 2 millimeters in its smallest cross-sectional dimension, (3) a silica to alumina ratio of at least about 12 and (4) a constraint index, as hereinafter defined, within the approximate range of 1 to 12.

55983 (FE—2490-8) **Fluid bed process studies on selective conversion of methanol to high octane gasoline. Monthly report for May 1977.** (Mobil Research and Development Corp., Paulsboro, N.J. (USA)). Jun 1977. Contract EX-76-C-01-2490. 22p. Dep. NTIS, PC A02/MF A01.

In the fluid bed flow studies the major accomplishments were the experimental testing of different designs for feed distributor and selection of a five-prong nozzle with atomizer, design of capacitance probe for high temperature operation, and testing of reactor cyclone with subsequent design improvement. In the methanol-to-gasoline pilot plant design and construction, the major accomplishments were the completion of the assembly of the reactor regenerator system, completion of wiring on the instrument panel, and installation of heating elements on the reactor regenerator system. (JSR)

55984 Process for producing combustible gases. Gent, C.W. (to Imperial Chemical Industries Ltd.). US Patent 4,028,067. 7 Jun 1977.

Priority date 10 Jun 1974, United Kingdom of Great Britain and Northern Ireland (UK). 6p.

A process for producing a substitute natural gas from methanol, especially seaborne methanol liable to be contaminated with chloride, comprises catalytically reacting methanol vapor in a decomposition stage at an outlet temperature above 550°C, cooling the resulting gas by indirect heat exchange, preferably with water, to 250 to 350°C, methanating the cooled gas with an outlet temperature of 500 to 650°C, cooling the methanated gas by indirect heat exchange, preferably with methanol, and methanating the resulting gas in at least one further methanation stage. By avoiding the injection of liquid methanol, as had been previously proposed, for cooling the hot gas, the poisoning of catalysts by impurities such as chloride does not take place. 4 claims, 1 figure.

55985 Gasification of hydrocarbon feedstocks. Moody, B.E.; Schuster, J.E. (to Air Products and Chemicals, Inc.). US Patent 4,025,318. 24 May 1977. Filed date 5 Oct 1976. 18p.

Hydrocarbon feedstock is first vaporized in the presence of hydrogen and then the vaporized hydrocarbon feedstock together with excess hydrogen, is gasified to form an effluent gas consisting essentially of methane and aromatic hydrocarbons together with hydrogen and minor amounts of hydrogen sulfide. The process is suitable for the production of a pipeline gas having a heating value of approximately 1,000 Btu/SCF by further processing the effluent, after separation of the aromatic fraction and hydrogen sulfide from the gasifier effluent; the effluent is subject to cryogenic separation of the hydrogen with the hydrogen being recycled to the gasification step and the methane being discharged into a product pipeline. The overall process contemplates revaporization of the aromatic fraction separated from the effluent and regasification to extinction of this fraction. Preferred feedstocks are crude oil, bitumen produced from tar sands, shale oil, liquid volatiles resulting from coking of coal, liquefied coal resulting from solvating coal with a solvent and hydrogen, aromatic hydrocarbons, naphtha, gas oils, crude oil distillates, and crude oil residues. It is contemplated that the gasifier effluent could be used as a feedstream for the production of a hydrogen-carbon monoxide synthesis gas, hydrogen, carbon monoxide or as a source of fuel to be burned in place of oil or other liquid hydrocarbons. 18 claims, 4 figures.

55986 Manufacture of hydrocarbons. Lago, R.M. (to Mobil Oil Corp.). US Patent 4,025,571. 24 May 1977. Filed date 12 May 1976. 12p.

A catalytic process is provided for converting a C_1—C_4 monohydric alcohol, an ether derived from said alcohol or a mixture of such alcohol and ether to a hydrocarbon mixture rich in C_2—C_3 olefins and mononuclear aromatics with high selectivity for para-xylene production by contact, under conversion conditions, with a catalyst comprising a crystalline aluminosilicate zeolite having a crystal size of at least about 1 micron, a silica to alumina ratio of at least about 12 and a constraint index, as hereinafter defined, within the approximate range of 1 to 12.

55987 Process for the methanation of gases containing high concentration of carbon monoxide. Galstaun, L.S. (to Bechtel Associates Professional Corp.). US Patent 4,017,274. 12 Apr 1977. Filed date 26 Feb 1976. 12p.

This invention relates to a process for the methanation of scrubbed raw gases containing a concentration of carbon monoxide in excess of 3 mole percent and a methane concentration of less than 25 mole percent which comprises reacting a part of the carbon monoxide contained in the raw gases in the presence of an effective amount of at least one steam reforming catalyst contained in a fixed bed, substantially adiabatic reactor with steam, water, or a steam and water mixture provided directly to the reaction zone to effect the shift conversion of a part of the carbon monoxide according to the equation $CO + H_2O$ equals $CO_2 + H_2$ and simultaneously to effect methanation of the remaining carbon monoxide with hydrogen up to the equilibrium point of the equation $CO + 3H_2$ equals $CH_4 + H_2O$ the amount of steam, water, or steam and water mixture being sufficient to maintain the temperature of the reactants below that at which cracking of the methane product in the methanation reaction can take place. 14 claims, 2 figures.

55988 Production of clean synthesis or fuel gas. Slater, W.L.; Richter, G.N.; Crouch, W.B.; Estabrook, L.E. US Patent 4,007,017. 8 Feb 1977. Filed date 22 Dec 1975. 10p.

An improved continuous partial oxidation process is claimed for producing clean synthesis or fuel gas from a hydrocarbonaceous fuel feed is disclosed wherein the effluent gas stream from the reaction zone of the gas generator is simultaneously cooled and cleaned by first discharging the gas stream directly into a relatively large body of hot liquid hydrocarbon immersion fluid contained in an immersion vessel, and second by scrubbing with by-product water obtained subsequently in the process in a nozzle scrubber. The process gas stream is optionally cooled and passed into a gas-liquid separator where any condensed by-product noxious water and any C_5—C_{10} liquid hydrocarbons are separated from each other and from the clean product gas stream. By-product noxious water is disposed of without polluting the environment by recycling a portion of it to the gas generator as the temperature moderator. For example, the immersion fluid may be a dispersion of liquid hydrocarbonaceous fuel such as petroleum oil and particulate carbon which is contained in a separate immersion vessel. A portion of the hot immersion fluid is continuously removed from the immersion vessel and is cooled in an external gas cooler to a temperature in the range of about 300 to 850°F but above the dew point of the water in the process gas stream. Portions of the cooled immersion fluid are recycled to the immersion vessel, and optionally to the gas generator as at least a portion of the hydrocarbonaceous fuel feed. In another embodiment, a portion of the immersion fluid removed from the immersion vessel may be introduced into the gas generator as at least a portion of the feed without first being passed through a cooler. The clean product gas comprises H_2, CO, CO_2, H_2O and, optionally at least one material from the group H_2S, COS, N_2, A, and C_1—C_4 hydrocarbons. 11 claims, 1 figure.

55989 Production of clean synthesis or fuel gas. Slater, W.L.; Richter, G.N.; Crouch, W.B.; Estabrook, L.E. (to Texaco Inc.). US Patent 4,007,018. 8 Feb 1977. Filed date 22 Dec 1975. 10p.

An improved continuous partial oxidation process is claimed for producing clean synthesis or fuel gas from a hydrocarbonaceous fuel feed is disclosed wherein hot gases from the process are simultaneously cooled and cleaned by direct contact with hydrocarbon oil. Thus, the effluent gas stream from the reaction zone of the gas generator is cooled and cleaned by discharging the gas stream directly into a relatively large body of hot liquid hydrocarbon immersion fluid. For example, the immersion fluid may be a dispersion of liquid hydrocarbonaceous fuel such as petroleum oil and particulate carbon which is contained in a separate immersion vessel. A portion of the immersion fluid is continuously removed from the immersion vessel and is cooled in an external cooler to a temperature in the range of about 300 to 850°F but above the dew point of the water in the process gas stream. Portions of the cooled immersion fluid optionally in admixture with scrubbing fluid obtained subsequently in the process are recycled to the immersion vessel, and optionally to the gas generator as at least a portion of the hydrocarbonaceous fuel feed. In another embodiment, a portion of the immersion fluid removed from the immersion vessel may be introduced into the gas generator as at least a portion of the feed without first being passed through a cooler. The effluent gas stream leaving said immersion zone may be subjected to additional cleaning by being scrubbed with said scrubbing fluid comprising make-up hydrocarbonaceous fuel and particulate carbon in a separate scrubbing zone. The clean product gas comprises H_2, CO, CO_2, H_2O and, optionally at least one material from the group H_2S, COS, N_2, A, and C_1—C_{10} hydrocarbons. 13 claims, 1 figure.

55990 Production of clean synthesis or fuel gas. Slater, W.L.; Richter, G.N.; Crouch, W.B.; Estabrook, L.E. (to Texaco inc.). US Patent 4,007,019. 8 Feb 1977. Filed date 22 Dec 1975. 12p.

An improved continuous partial oxidation process is claimed for producing clean synthesis or fuel gas and by-product steam from a hydrocarbonaceous fuel feed is disclosed wherein hot gases from the process are simultaneously cooled and cleaned by direct contact with hydrocarbon oil. Thus, the effluent gas stream from the reaction zone of the gas generator is cooled and cleaned by discharging the gas stream directly into a relatively large body of hot liquid hydrocarbon immersion fluid. For example, the immersion fluid may be a dispersion of liquid hydrocarbonaceous fuel such as petroleum oil and particulate carbon which is contained in a separate immersion vessel. A portion of the hot immersion fluid is continuously removed from the immersion vessel and cooled to a temperature in the range of about 300 to 850°F but above the dew point of the water in the process gas stream in an external heat exchanger, such as a steam generator. High pressure by-product stream may be produced thereby. A portion of the cooled immersion fluid, optionally in admixture with a hydrocarbonaceous scrubbing fluid of a similar composition obtained subsequently in the process may be recycled to the immersion vessel and optionally to the gas generator as at least a portion of the hydrocarbonaceous fuel feed. 14 claims, 1 figure.

55991 North Thames shuts down last gas-making station. de Winton, C. *Gas World Gas J.*; **181**: No. 4695, 582-584(Oct 1976).

The shutdown of the last gas manufacturing plant in the North Thames Region, in fact the last in England and Wales, is described. Conversion from manufactured gas to natural gas was officially completed Aug 23, 1976. The reforming plant had been the last to supply manufactured gas to the Region's grid system. The past production record of the Romford gas-making plant is briefly reviewed.

PREPARATION FROM WASTES OR BIOMASS

55992 Process and apparatus for the production of combustible gas. Kiener, K. US Patent 4,028,068. 7 Jun 1977. Priority date 4 Jul 1974, German, Federal Republic of (F.R. Germany). 12p.

A process is claimed for the production of combustible gas from waste materials and other combustible materials, in which the charge is dried, its combustible parts are subjected to low-temperature carbonization and the low-temperature carbonization gases are converted to combustible gas in a hot reaction bed. The charge is subjected to low-temperature carbonization at a temperature of from 300 to 600°C with the exclusion of air, the resulting solid low-temperature carbonization residues are separated and the low-temperature carbonization gases are continuously drawn through a reaction bed at a temperature of from 1000 to 1200°C formed from a solid carbon vehicle and a preheated fresh-air supply, and are converted to high-energy combustible gas in said reaction bed. 7 claims, 4 figures.

55993 Pyrolysis process for converting refuse to fuel gas. Anderson, J.E. (to Union Carbide Corporation). US Patent 4,017,273. 12 Apr 1977. Filed date 26 May 1976. 6p.

This invention relates to improving the known process for disposing of refuse while simultaneously producing a useful gaseous product and an inert solid residue in a shaft furnace in which refuse is fed into the top portion of said furnace, an oxygen containing gas is fed into the base, and in which the organic portion of the refuse is pyrolized to char, oils and gas containing a high concentration of CO and H_2, and the inorganic portion of the refuse is fluidized and tapped from the base of the furnace. The improvement in the above-described process comprises removing a portion of the char from the furnace while retaining a sufficient amount of combustible materials in the furnace to satisfy the energy requirements of the process. The improvement permits a reduction in the oxygen requirements of the process and has a beneficial effect on the specific heating value of the fuel gas produced. 2 claims, 1 figure.

55994 Don't waste waterweeds. Wolverton, B.; McDonald, R.C. (National Space Tech. Labs., Bay St. Louis, MS). *New Sci.;* 318-320(12 Aug 1976).

The water hyacinth which has clogged rivers and streams in the southeastern United States and many tropical countries can be used to treat liquid effluents and is a potential source of fertilizer, biogas from anaerobic digestion, and livestock feed. Research being sponsored by NASA to investigate these uses of water hyacinths is briefly described. (JSR)

PREPARATION

CHEMICAL SYNTHESIS

55995 Molding of a low-temperature catalyst for methanol synthesis. Azaev, G.A.; Chistozvonov, D.B.; Sobolevskii, V.S. (Leningrad Inst. of Tech.). *J. Appl. Chem. USSR (Engl. Transl.);* 49: No. 10, 2289-2292(Oct 1976).

Translated from Zh. Prikl. Khim.; 49: No. 10b, 2284-2288(Oct 1976).

Preparation of a low temperature catalyst (NTK-2M) comprised mainly of zinc and copper chromates for the synthesis of methanol is described. Temperature ranges corresponding to the removal of adsorbed and crystallized water from the contact material and the range of copper and zinc chromate decomposition were determined. X-ray phase analysis of the catalyst showed the presence of some phases not previously described in the literature. The addition of promoting additives, Al_2O_3, MgO, or MnO, to the catalyst did not have a significant effect on the catalytic properties. The macroporous structure was formed mainly during tabletting, and further heat treatment served only to change the total pore volume.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 55981

PROPERTIES

55996 Kinetics of the reaction between hydrazine and nitric acid catalyzed by molybdenum(VI). Koltunov, V.S.; Tikhonov, M.F.; Kuperman, A.Ya. *Russ. J. Phys. Chem. (Engl. Transl.);* 50: No. 10, 1521-1524(Oct 1976).

Translated from Zh. Fiz. Khim.; 50: No. 10, 2542-2546(Oct 1976).

The kinetics of the oxidation of hydrazine by nitric acid in the presence of molybdenum(VI) have been investigated. The reaction products are NH_3, HN_3, N_2O, and N_2. The stoichiometry of the reaction has been established and a kinetic equation, valid at 92°C and the ionic strength I = 2.1, has been derived. The activation energy and entropy are respectively 26.5 kcal $mole^{-1}$ and 8 eu. The mechanism of the reaction, in which dimerised molybdenum (V) interacts with N_2H_4 in the slow stage forming molybdenum(IV) and N_2H_3 radicals, is discussed. In the subsequent rapid stages, molybdenum(IV) is oxidised by HNO_3 and the N_2H_3 radicals dimerize and decompose into N_2, NH_3 and HN_3.

55997 Mechanism of the decomposition of ammonia on nickel films at temperatures below and above the Curie point. Denisov, G.N.; Yagodovskii, V.D.; Makeicheva, I.I. (Patrice Lumumba Friendship of Nations Univ., Moscow). *Russ. J. Phys. Chem. (Engl. Transl.);* 50: No. 9, 1364-1367(Sep 1976).

Translated from Zh. Fiz. Khim.; 50: No. 9, 2278-2281(Sep 1976).

A change in the kinetics of the catalytic decomposition of ammonia on nickel films was noted on conversion of the catalyst from the ferromagnetic to the paramagnetic state. This change is attributed to a change in the reaction mechanism. By combining the results of conductimetric and photoelectric measurements with measurements of the magnetisation of the film, it was concluded that below the Curie point the recombination-limited desorption of nitrogen is rate-determining, and above the Curie point the rate-determining step is the dissociation of imino radicals.

PREPARATION

REFER ALSO TO CITATION(S) 55810

55998 Energetics and mechanism of sonochemical reactions. V. The formation of hydrogen peroxide in the sonolysis of water and aqueous solutions of formates. Margulis, M.A. *Russ. J. Phys. Chem. (Engl. Transl.);* 50: No. 10, 1515-1518(Oct 1976).

Translated from Zh. Fiz. Khim.; 50: No. 10, 2531-2535(Oct 1976).

The mechanism of the synthesis of hydrogen peroxide in an atmosphere of inert and chemically reactive gases has been investigated and it has been shown that, in the presence of formate ions, the rate of accumulation of H_2O_2 under the influence of ultrasonic waves is greatly reduced in atmospheres of inert gases owing to a sharp decrease of the rate of reaction of hydrogen peroxide with $HCOO^-$ ions and not the capture of hydroxy-radicals. This is not inconsistent with the model according to which hydrogen peroxide is formed owing to the recombination of radicals within cavitation bubbles. The high energetic yield of the decomposition of hydrogen peroxide in the presence of sodium formate suggested the occurrence of a chain reaction under the influence of ultrasonic waves. Equations have been obtained for the sonochemical yield of H_2O_2 in atmospheres of inert gases and oxygen.

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 56247, 56248, 56249, 56980, 56981, 56987, 57022

55999 (CONS/2103—1) European waste-to-energy systems: case study of the thermal complex of Toulouse-Le Mirail (France). (Resource Planning Associates, Inc., Washington, D.C. (USA); Resource Planning Associates, Inc., Paris (France)). May 1977. Contract EC-77-C-01-2103. 45p. Dep. NTIS, PC A03/MF A01.

The waste treatment system of Toulouse-Le Mirail (France) is a complex composed of an incinerator with heat-recovery equipment and an oil-fired heating facility. It was designed to burn the household waste of a city of 400,000 inhabitants while at the same time providing central heating and hot water to a suburb of 100,000 inhabitants. Sufficient electricity is also generated for in-plant use. Technical data for the system are reported in detail. The economics and management are reviewed. The system has operated for five years without major problems. (JSR)

56000 (PB—265392) Energy potential from construction and demolition wood wastes. Final report 1976. (JACA Corp., Fort Washington, Pa. (USA)). 7 Apr 1977. Contract EPA-68-01-3560. 65p. NTIS PC A04/MF A01.

Energy shortages and the need to conserve natural resources have led the United States to examine its waste streams as sources of potential supplies of energy and reconstituted products. While solid waste energy potentials in the private sector have been examined in some detail, construction and demolition wastes have not heretofore received comparable study attention. Therefore, the first step in analyzing a reuse program is the development of the size and nature of the particular waste stream. The objective of this report was to determine the nationwide volume of construction and demolition wastes, and, in particular, the combustible fraction of wastes from these activities. Ancillary outputs of the study are annual generation rates by location, information on time variation in waste flows, and the distribution of wood fractions.

56001 Refuse incineration and heating in middle-sized cities. *Energie;* **28:** No. 11, 317-321(Nov 1976). (In German).

Experiences gained with an extension of an incinerator which serves some 200,000 inhabitants are given. The additional equipment has consisted of gas turbines and generators.

HYDRO ENERGY

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 55665, 56986

56002 (PB—264750) Water resources appraisal for hydroelectric licensing Kern River Basin, California. (Federal Power Commission, Washington, D.C. (USA). Bureau of Power). 1977. 94p. NTIS PC A05/MF A01.

Information on existing and possible future development of water and related land resources in the Kern River Basin is presented. The basin is part of the Central Valley in south-central California.

56003 Waterpower: a short overview. Kristoferson, L. (R Inst of Technol, Stockholm, Swed). *Ambio;* **6:** No. 1, 44-45(1977).

Of the globe's waterpower resources, only 13 percent have been exploited, and most of the undeveloped resources are located where they are needed most--in developing countries. The article discusses the environmental impact of waterpower, and notes that the extensive use of small or village-sized units could help to avoid societal and environmental disruptions sometimes associated with the development of large-scale waterpower in developing countries.

SITE GEOLOGY AND METEOROLOGY

56004 Major rock excavations at Dinorwic, Wales. *Min. Mag.;* **136:** No. 4, 283, 285(Apr 1977).

Major excavation work, undertaken within the framework of the Dinorwic power generation project in northern Wales is briefly described. The project involves a considerable amount of hard rock tunneling and excavation work. Inlet tunnels, with a diameter a combined length of about 3 km will conduct water from an upper reservoir to six turbines, each with an output of 300 MW. Strata control necessary for roof and wall stabilization in the tunnels is also described.

PLANT DESIGN AND OPERATION

56005 Effect of small geometric deviations of the shape of rotor blades of hydraulic turbines on their hydraulic qualities and cavitation erosion. Busyrev, A.I.; Kuzminskii, S.S.; Pylev, I.M.; Staritskii, V.G.; Chechel', N.S. *Energomashinostroenie;* No. 1, 4-6(1977). (In Russian).

Results of model tests are presented. It is concluded that hydraulic characteristics of the hydraulic turbine depend considerably on the angular position and shape of the leaving and leading elements of the rotor blade system. It is recommended to narrow the tolerance limits in this respect to maintain turbine hydraulic characteristics.

56006 Hydraulic calculation of hydroelectric power station spillways. Mustafin, Kh.Sh. (Kuban' Agric Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 10, 95-101(Oct 1976). (In Russian).

When calculating the throughput capacity of a spillway at hydroelectric power plants of a combined type and of dams with head spillways, where the water duct section is of considerable height compared with the effective head of the structure, it is necessary to take into account the effect of the level of the lower water on the formation of the pressure diagram in the outlet section of the spillway. A method is presented for the calculation of the pressure diagram and local velocities in the outlet section of the water duct in conditions of a plane problem taking into account the depth of the downstream water. Relations are given which permit calculation of the head and flowrate characteristic curve. A comparison of theoretical results with experimental data shows that the proposed relations are acceptable for practical calculations.

56007 Hydrodynamic theory of supercavitating pumps or hydroturbines. Ivchenko, V.M. *Fluid Dyn. (USSR) (Engl. Transl.);* **11:** No. 1, 137-142(Jan-Feb 1976).

The article sets forth a three-dimensional linearized theory of a supercavitating pump or hydroturbine with finite dimensions of the blades and cavities, in a tube of round cross section. A fundamental solution is constructed (the potential of a source in a tube), and numerical methods are indicated for solution of the direct and inverse problems, required for the detailed design and calculation of axial hydromachines, under conditions of developed cavitation. Some results of the calculations are given.

56008 Profiling of blades of the working region of the hydraulic turbines in vortex-type flow. Zhukovskii, M.I.; Golovachev, Yu.P. *Energomashinostroenie;* No. 9, 9-12(1976). (In Russian).

An axisymmetrical problem of profiling in the vortical flow of hydraulic turbine blades is formulated and numerically solved. The method of nets is used for flow calculations and the method of nets and characteristics--for the determination of the shape of the middle blade surface. A program for the M-220 computer is worked out. An example of calculation is presented.

56009 Specific features of construction and assembly of rotor chambers of large rotary blade hydraulic turbines. Gal'perin, M.I.; Balgurov, E.V.; Fiterman, Ya.F. *Energomashinostroenie;* No. 11, 24-27(1976). (In Russian).

The experience of assembling stamped and welded rotor chambers without machining them on vertical turning lathes and boring columns is related. This reduces corrosion and cavitation considerably.

56010 Modeling of loads on hydraulic machinery blades. Zubarev, N.I. *Energomashinostroenie;* No. 10, 43-44(1976). (In Russian).

Conditions which have to be met by thicknesses of blades of a model hydraulic machine to make their stresses equal to the stresses in the blades of natural-size hydraulic machine are formulated. It is understood that the model and natural-size machine head pressures are different. It is also shown that, while there are equal stresses due to hydrodynamic forces, the stresses due to centrifugal forces are not equal. A method to take into account this inequality is recommended.

56011 Problems of technology of manufacture of hydraulic generator shafts and related consequences for assembly and operation of hydraulic units. Rudnik, A.G. *Energomashinostroenie;* No. 12, 43(1976). (In Russian).

A new technology of machining the shafts of hydroelectric generators to prevent any distortion of their line is briefly described. The rotor bushing and the shaft neck bushings are hot fitted on to the shaft and then all machining adjustments are made on one machine at the factory.

ECONOMICS AND MANAGEMENT

REFER ALSO TO CITATION(S) 56885

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 56923

56012 (PB—264753) Significant interrelationships between electric power generation and natural and developed resources in the Connecticut River Basin. (Federal Power Commission, Washington, D.C. (USA). Office of Energy Systems). Dec 1976. 280p. NTIS PC A13/MF A01.

The interrelationships between hydroelectric power and natural resources in an entire river basin are assessed. A methodology for assessing these interrelationships that has applicability in preparing comprehensive environmental impact statements on entire river basin systems is presented.

56013 Should dams be built. The Volta Lake example. Obeng, L. (UN Environ Program, Nairobi, Kenya). *Ambio;* **6:** No. 1, 46-50(1977).

Describing environmental and societal effects of the Volta Lake project, the article discusses the pros and cons of large dams. In many parts of the world, especially in many developing countries and particularly in Africa, waterpower is the only large potential power source. It is therefore highly desirable that available information be utilized in future dam schemes to minimize environmental and other hazards.

SOLAR ENERGY

REFER ALSO TO CITATION(S) 57834

56014 Overview of the federal solar energy program and current technology status. Herwig, L.O. (Energy Research and Development

Administration, Washington, DC). *Trans. Am. Nucl. Soc.;* 26: 1(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56015 Comparative analysis of solar energy applications to the year 2000 and beyond. Bennington, G.; Scholl, M. (MITRE/METREK, McLean, VA). *Trans. Am. Nucl. Soc.;* 26: 2(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56016 Sharing the Sun: solar technology in the seventies. Volume 8. Storage, water heater, data communication education. Contains sections 13.1, 13.2, 13.3, 15, 16, 5. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976). 382p. (CONF-760842—P8).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

The 32 papers presented were abstracted and indexed separately for ERDA Energy Research Abstracts (ERA). Eight of the papers are included in Energy Abstracts for Policy Analysis (EAPA). (WHK)

56017 Academic program in solar energy science education. Meyers, A.C. III. (Univ. of Northern Iowa, Cedar Falls). pp 273-278 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

An actual program which is endeavoring to attack the problem of scientific education in Solar Energy on two levels is described. The first level is with respect to the professional personnel who might apply solar energy to solving scientific and engineering problems. The second level is two-fold, one with respect to junior and senior high school teachers who need information on solar energy in order to add sections on this subject to their science courses, and two, to provide a means whereby interested individuals in the community can learn the basics of solar energy. Units on various areas of solar energy have been developed and added to other appropriate physics and physical science courses.

56018 Integrating solar energy concepts into chemistry/science curriculum. Centrell, J.S. (Miami Univ., Oxford, OH). pp 279-287 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

Solar energy concepts should be stressed whenever they arise in the normal patterns of teaching Chemistry/Science. As the energy shortages becomes more acute and fuel prices soar, graduates from high school, and two or four year colleges, may never learn the basic information about solar collectors unless an attempt is made to present this material as early as possible in their program. Samples of curriculum modification for informing the public on solar energy concepts are included based on the thought that an informed public is more likely to support research and development of solar technology.

56019 Solar energy information system (a proposal). Borovansky, V.T. (Arizona State Univ., Tempe). pp 311-314 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

The proposal is to establish an information analysis centre whose objectives would be to develop solar energy information essentially to national energy needs and to provide a highly effective information service for solar energy researchers, investigators, federal, state and local authorities.

56020 Solar energy collection at Arizona State University. Beecher, M.E. (Arizona State Univ., Tempe). pp 315-317 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

The former Research Collection of the ISES constitutes the nucleus of the Solar Energy Collection at the Arizona State University Library. Its history and development is discussed, and appreciation is expressed to the Society for the gift. Suggestions are made for the use of services now available to the public.

56021 "Solar switchboard": an interim analysis of an experiment in the dissemination of solar energy information to the public. Aitken, D.W. (San Jose State Univ., CA); Rozell, D.K.; Niland, P. pp 318-332 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

An analysis is presented of the first eleven weeks of operation of a State-supported solar-energy information service housed at San Jose State University and staffed by University students. The service, conducted by collect telephone calls placed to the Switchboard, covers all of Northern California. The analysis is derived from 654 telephone calls, and reveals the time-dependent distribution of the calls, the dependence of the public response upon staffing hours and media coverage, the experience of the Solar Switchboard staff, and the subsequent experience of some of those served by the Switchboard, as learned from followup calls initiated out of the funding agency's office. Conclusions are drawn which support the considerable social and educational value of this kind of activity, but which also offer suggestions for improvements in activity scope, mode of operation, and supporting information and evaluation capabilities.

RESOURCES AND AVAILABILITY

56022 (PB—265282) Comparison of a thermopile broadband detector and a photon detector for the measurement of solar radiation. Part I. Analysis of simultaneous data. Part II. Cosine response functions. Dias, M.S.; Davis, J.; Cox, S. (Colorado State Univ., Fort Collins (USA). Dept. of Atmospheric Science). Mar 1976. 55p. NTIS PC A04/MF A01.

Sponsored in part by National Science Foundation, Washington, D.C. Global Atmospheric Research Program.

Solar radiation instruments manufactured by Eppley Laboratories and Lambda Instruments are compared. The primary method of comparison was a detailed inspection of data collected simultaneously from each of the instruments during the summer and autumn of 1975 at Fort Collins, Colorado. Data were stratified both as a function of sky cover and solar zenith angle.

56023 (SAND—77-1047C) Pyranometer calibration: leveling errors and cosine effect. Thacher, P.D.; Petterson, B.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 3p. (CONF-770723—1). Dep. NTIS, PC A02/MF A01.

From Solar data users workshop; Albuquerque, New Mexico, USA (7 Jul 1977).

The solar monitoring system for the Sandia Total Energy Systems Test Facility consists of a fixed, horizontal pyranometer and a tracking pyranometer and pyrheliometer. Readout uses a scanned A-D converter with recording via print-out, magnetic tape, or disk. The Eppley pyrheliometer is calibrated by direct comparison with a Kendall electrically-calibrated radiometer. The pyranometers, model PSP, also from Eppley, are calibrated against the pyrheliometer using shading techniques; and the parameters affecting that calibration are the subject of this summary.

56024 Calculation of the parameters of a radiant flux receiver, taking into account its exchange with the environment. Dikareva, R.P.; Samoilova, A.Ya.; Samoilov, E.M. (Novosibirsk Electrotech Inst, USSR). *Geliotekhnika;* No. 6, 14-17(1976). (In Russian).

For precise calculation of the parameters of semiconductor receivers of radiant thermal fluxes, it is necessary to take into account thermal losses through the lateral surface of a thermoelement. The paper presents calculation of sensitivity and time lag. The results are corroborated by experimental data.

56025 Basis for the development of a solar energy cadaster. Salieva, R.B. (Tashkent Electrotech Inst, Uzb SSR). *Geliotekhnika;* No. 6, 61-77(1976). (In Russian).

Principles of elaboration of a solar energy cadastral survey are considered. An attempt is made to construct a mathematical model according to the parameters of which (with certain norms of provision) it would be possible to determine useful capacity of any solar energy plant of any design and to justify the efficacy and

expediency of its application to this or that local landscape. The model is viewed from the position of the theory of random processes. Modeling algorithms and their computer-aided realization are presented. The final result is presented in the form of calculation by means of which useful capacity and the coefficient of utilization of the installed capacity of plant of any design can be determined. 12 refs.

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 56923

56026 Facilitating the use of solar building technologies; a report on work in progress. Masterson, C. (AIA Research Corp., Washington, DC). *IF (Ind. Forum)*; 7: No. 2-3, 95-102(1976).

Too much emphasis has been placed on technological innovation; it is necessary to consider the processes that are necessary to produce and distribute new products, and also to develop the accompanying knowledge base and motivations. The innovation process is nonlinear when seen in human terms. A study has been made of the ways in which public and private institutions can facilitate the widespread use of solar technologies for building. A survey of early users reveals a number of problems including; surviving false starts, involving key participants, overcoming lack of knowledge, resolving difficulties with bidding and quality assurance, etc. The use of solar technologies involves changes in the industry and the adoption of a knowledge-based approach.

SOLAR ENERGY CONVERSION

56027 Assessment of hydrogen as a means to store solar energy. Ramakumar, R. (Oklahoma State Univ., Stillwater). pp 163-175 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

A brief review and assessment of the use of hydrogen as a means to store solar energy is presented. Electrolytic and non-electrolytic methods proposed for hydrogen production from solar energy, hydrogen storage methods and utilization techniques are surveyed. Overall system concepts with several manifestations of solar energy as inputs are discussed along with their efficiencies and economic aspects.

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 56122, 56141

56028 (CONF-761130—4) Studies related to Zn/sub x/Cd/sub 1-x/S solar cells. Technical report IEC/PV/TR/76/4. Burton, L.C.; Baron, B.; Devaney, W.; Hench, T.L.; Lorenz, S.; Meakin, J.D. (Delaware Univ., Newark (USA). Inst. of Energy Conversion). Nov 1976. Contract EX-76-C-01-2538. 14p. Dep. NTIS, PC A02/MF A01.

From 12. IEEE photovoltaic specialists conference; Baton Rouge, Louisiana, United States of America (USA) (15 Nov 1976).

Zn/sub x/Cd/sub 1-x/S films suitable for use in solar cells have been deposited and characterized. Zn/sub x/Cd/sub 1-x/S-Cu_2S heterojunctions with reproducible open circuit voltages of .67 to .68 volts have been fabricated. Barrier height measurements indicate that the increased open circuit voltage is due to an improved match between the mixed sulfide and Cu_2S electron affinities.

56029 (CONF-770439—1) Transmutation doping of silicon solar cells. Wood, R.F.; Westbrook, R.D.; Young, R.T.; Cleland, J.W. (Oak Ridge National Lab., Tenn. (USA)). Apr 1977. Contract W-7405-ENG-26. 11p. Dep. NTIS, PC A02/MF A01.

From High efficiency radiation damage silicon solar cell meeting; Cleveland, Ohio, United States of America (USA) (28 Apr 1977).

Normal isotopic silicon contains 3.05 percent of ^{30}Si which transmutes to ^{31}P after thermal neutron absorption, with a half-life of 2.6 hours. This reaction can be used to introduce extremely uniform concentrations of phosphorus into silicon, thus eliminating the areal and spatial inhomogeneities characteristic of chemical doping. Annealing of the lattice damage in the irradiated silicon does not alter the uniformity of dopant distribution. Transmutation doping also makes it possible to introduce phosphorus into polycrystalline silicon without segregation of the dopant at the grain boundaries. The use of neutron transmutation doped (NTD) silicon in solar cell research and development is discussed.

56030 (EPRI-ER—478) Silicon photovoltaic cells in thermophotovoltaic conversion. Progress report. Swanson, R.M.; Bracewell, R.N. (Stanford Univ., Calif. (USA). Stanford Electronics Labs.). Feb 1977. 27p. Dep. NTIS, PC A03/MF A01.

A preliminary assessment of the feasibility of a solar-electric thermophotovoltaic (TPV) system has been performed. In concept, the proposed system uses concentrating mirrors focused on a TPV converter that operates at high power density and potentially high efficiency. Within the TPV converter, the concentrated sunlight heats a refractory radiator. A photovoltaic cell faces the radiator, receives incandescent radiation from it, and converts the radiation to electricity. A numerical model of TPV conversion was developed to assess TPV conversion and to facilitate an intitial design of TPV photocells. Also, a facility for experientally evaluating TPV photocells was designed and built.

56031 (ERDA/JPL/954144—77/1) Silicon ribbon growth by a capillary action shaping technique. Quarterly technical progress report number 7. Schwuttke, G.H.; Ciszek, T.F.; Kran, A. (International Business Machines Corp., Hopewell Junction, N.Y. (USA). East Fishkill Lab.). 1 Apr 1977. Contract NAS-7-100-954144. 78p. Dep. NTIS, PC A05/MF A01.

The crystal-growth method under investigation is a capillary action shaping technique. Meniscus shaping for the desired ribbon geometry occurs at the vertex of a wettable die. As ribbon growth depletes the melt meniscus, capillary action supplies replacement material. Progress in 50-mm-wide ribbon growth is detailed. Over 11 meters of uniform 50-mm-wide ribbon have been grown this quarter. Fuller advantage has been taken of the potential benefits of high melt meniscus (HMM) growth. 50-mm ribbons less than 0.27 mm in thickness were produced with zero SiC particle density, smooth reflective surfaces, and lifetimes greater than 20 μsec for electrical charge carriers. It has also been demonstrated that quartz crucibles can be used through at least four melt-down cycles. A computer analysis model of competing sheet growth techniques is presented and discussed. (WHK)

56032 (ERDA/JPL/954331—77/2) Silicon Materials Task of the Low Cost Solar Array Project (Phase II). Sixth quarterly report, 1 January 1977—March 31, 1977. Hopkins, R.H.; Davis, J.R.; Rai-Choudhury, P.; Blais, P.D.; McCormick, J.R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Research and Development Center; Dow Corning Corp., Hemlock, Mich. (USA)). 1977. Contract NAS-7-100-954331. 48p. Dep. NTIS, PC A03/MF A01.

Preliminary studies have been conducted to develop a foundation for the work to be carried out in Phase II of the program, which is designed to investigate the effects of processes and impurities on terrestrial silicon solar cells. Solar cells nearly 10% efficient (without AR coatings) can be made on p-type material with resistivities down to about 0.2 Ω-cm using a process similar to that employed during Phase I of the program. As resistivity falls below about 0.1 Ω-cm cell efficiency also falls and process instabilities become more prevalent. For this reason the resistivity of the baseline material chosen to study the combined effects of boron and metal doping will probably be in the 0.1 to 0.3 Ω-cm range. Initial studies on n-base material indicate that 0.2 μm deep junctions with adequate sheet resistivities can be obtained by boron diffusion from BBr_3 at 875°C. Slow cooling from the diffusion temperature appears necessary to maintain good lifetime and I/sub sc/ values. $p^+/n/n^+$ cells fabricated on a Westinghouse internal program using this type of processing produce coated cells with 16% efficiencies. Future studies will focus on metal impurity doping of low resistivity p-type and n-type substrates and on gettering and heat treatment effects in standard 4 Ω-cm p-type material.

56033 (ERDA/JPL/954339—77/1) Evaluation of selected chemical processes for production of low-cost silicon (Phase II). Silicon Material Task, Low-Cost Silicon Solar Array Project. Fifth—sixth quarterly progress report, October 1, 1976—March 31, 1977. Blocher, J.M. Jr.; Browning, M.F.; Wilson, W.J.; Carmichael, D.C. (Battelle Columbus Labs., Ohio (USA)). 29 Apr 1977. Contract NAS-7-100-954339. 69p. Dep. NTIS, PC A04/MF A01.

The results of experimental work and economic analyses carried out during the first 12 months of this contract (Phase I) have led to Battelle's concentration on development of the zinc reduction of silicon tetrachloride on seed particles in a fluidized bed. A second year program (Phase II) has been initiated which consists of the design of a 25 MT/year experimental facility and supporting experiment effort. During this quarter, the effort in the plant design portion of the program has been devoted to the (1) preparation of a detailed process schematic diagram; (2) determination of material flow and energy requirements; (3) conceptual design of major equipment items, including those unique to the facility; (4) contacts with industrial companies on equipment and processes for which experience is available; and (5) initiation of contacts with Battelle pilot plant design specialists, a distillation consultant, and engineering

firms. The effort in the experimental support portion of the program has included a continuation of the following studies: (1) operating parameter optimization in the miniplant, (2) reactor design, and (3) condenser system design, including supplemental condensation experiments. In addition, a new zinc feed system has been devised and evaluated, and the construction of a system sufficiently large to obtain meaningful data on the electrolytic recovery of zinc from zinc chloride has been initiated.

56034 (ERDA/JPL/954343—77/2) **Process feasibility study in support of silicon material Task I. Quarterly technical progress report (VII).** Hansen, K.C.; Miller, J.W. Jr.; Yaws, C.L. (Lamar Univ., Beaumont, Tex. (USA). Dept. of Chemical Engineering). Jun 1977. Contract NAS-7-100-954343. 44p. Dep. NTIS, PC A03/MF A01.

During this reporting period, major activities were continued on process system properties, chemical engineering and economic analyses for application to alternate processes under consideration for solar cell grade silicon. In Task 1, primary efforts were devoted to properties of silicon source materials. For silane, liquid viscosity data were correlated as a function of temperature to cover the entire liquid range. Estimates for gas and liquid thermal conductivity are reported. For Task 2, major efforts were devoted to preliminary process design for the conventional polysilicon process based on the rod reactor (hairpin) technology. The criteria for design were selected to be commensurate with the design basis for the alternate processes to produce solar cell grade silicon. Chemical engineering analysis activities in Task 2 also focused on preliminary process design for a silane (SiH_4) plant. A revised flowsheet received from Union Carbide has received a preliminary review, and process design has been reinitiated. In Task 3, preliminary cost analysis is in progress for the conventional polysilicon process used in the United States and Europe for the production of semiconductor grade polysilicon. Plant investment and product cost estimates will be determined upon completion of review of major process equipment and production labor requirements.

56035 (ERDA/JPL/954344—77/1) **Web-dendritic ribbon growth. Quarterly report, January 1, 1977—March 31, 1977.** Hilborn, R.B. Jr.; Faust, J.W. Jr. (South Carolina Univ., Columbia (USA). Coll. of Engineering). 26 Apr 1977. Contract NAS-7-100-954344. 36p. Dep. NTIS, PC A03/MF A01.

This is a report of the sixth quarter's work on the web-dendritic ribbon growth process at the University of South Carolina. The goal of the program is to develop a multivariate semi-empirical computer model for use in understanding the web-dendritic process and defining the basic limitations of the process with particular regard to the growth rate and width. A brief description of the work carried-out and the results achieved during the past quarter are given.

56036 (ERDA/JPL/954350—77/1) **Large area silicon sheet task low-cost silicon solar array project. Fifth quarterly progress report, January 1, 1977—April 1, 1977.** Garfinkel, M.; Hall, R.N. (General Electric Co., Schenectady, N.Y. (USA)). 12 Apr 1977. Contract NAS-7-100-954350. 20p. Dep. NTIS, PC A02/MF A01.

The seeded growth furnace with the slotted molybdenum susceptor has been operated during the past quarter. Flat sheets of sapphire were used as the tray, and local cooling at the tin-silicon alloy surface was provided by a symmetric water-cooled jet. The silicon surface growth obtained during the past quarter has been consistently polycrystalline. This poor growth is attributed to impurities in the seeded growth furnace, caused by leakage into the system. Two sources have been identified: deteriorating neoprene O-rings and leaks of cooling water from the jet nozzle. The O-rings were replaced with indium gaskets, and the nozzle is being rebuilt. Weight loss measurements of the sapphire tray plates indicate that they suffer negligible attack by tin-silicon alloy melts at 1000° to 1100°C. The growth habit of crystals nucleated spontaneously at the tin-silicon alloy melt surface has been studied. The crystal growth observed is consistent with dendritic and web growth from (111) singly twinned triangular nuclei. Examples of planar surface growth of small (less than 0.1 mm), thin crystals from these twinned surface seeds have been observed.

56037 (ERDA/JPL/954352—77/1) **Automated array assembly. Annual report.** Williams, B.F. (RCA Labs., Princeton, N.J. (USA)). May 1977. Contract NAS-7-100-954352. 88p. (PRRL—77-CR-4). Dep. NTIS, PC A05/MF A01.

The goal of the ERDA/JPL LSSA program of $0.50/W selling price for array modules in 1986 turns out to have been remarkably appropriate. An extensive and detailed analysis of technologies which could be related to array module manufacturing was completed and a minimum manufacturing cost in a highly automated line of $0.30/W was found assuming the silicon is free. The panels are of a double glass construction and are based on round wafers. Screen printed silver has been used as the metallization with a spray-coated AR layer. The least expensive junction formation technology appears to be ion implantation; however, several other technologies also may be used with very little cost penalty as described. Based on the required investment, a profit of $0.05/W appears reasonable. If silicon wafers are available at a price of $20 to 40/$M^2$, a selling price for these array modules of $0.50 to 0.66/W is projected. An analysis of the impact of factory size has been made. For a production level of 500 MW/yr, the price above is derived. For comparison, a factory processing 50 MW/yr using the same technology would sell modules for $0.54/W to $0.70/W. An analysis of the impact of wafer size indicates that with traditional metallization and panel designs there is no advantage in increasing wafer size from 3 in. to 5 in., and, in fact, there is some penalty (10% in $/W) due to increasedmetallization costs and reduced system performance. There is a premium placed on high efficiency due to its impact, not only on array module cost, but on system cost. For the near term goals of this program, wafers cut from single-crystal material seem the most likely sheet configuration.

56038 (ERDA/JPL/954442—77/2) **Semiconductor grade, solar silicon purification project. Technical quarterly report No. 5, January 1, 1977—March 31, 1977.** Ingle, W.M. (Motorola, Inc., Phoenix, Ariz. (USA). Semiconductor Group). 7 Apr 1977. Contract NAS-7-100-954442. 54p. Dep. NTIS, PC A04/MF A01.

An investigation has been undertaken to examine the potential for a three step SiF_2 polymer transport purification process. The process involves reacting low cost mg silicon with SiF_4 to yield SiF_2 gas which is condensed to form polymeric (SiF_2)/sub x/. The polymer is then heated above 400°C to yield Si, SiF_4 and higher Si/sub n/F/sub 2n+2/ homologues. Continuing progress is reported and discussed on (i) modifications made on the purification apparatus to mitigate silicon product contamination, (ii) rate and kinetic experiments, (iii) mass spectral analysis of the conversion of amorphous silicon to dendritic silicon, (iv) preliminary experiments leading to the preparation of the final sample at maximum rate and purity, and (v) sample analysis.

56039 (ERDA/JPL/954471—77/1) **Novel duplex vapor-electrochemical method for silicon solar cells. Quarterly progress report No. 4, November 1, 1976—January 31, 1977.** Kapur, V.K.; Nanis, L.; Sanjurjo, A. (Stanford Research Inst., Menlo Park, Calif. (USA)). 1977. Contract NAS-7-100-954471. 18p. Dep. NTIS, PC A02/MF A01.

Silicon was separated from the other reaction products (NaF and Na_2SiF_6) by leaching the sodium fluorides with 1.2 N HCl solution. The acid leaching of the sodium fluorides in a glass container was found to be contaminating the silicon product. An all-plastic leaching system is being constructed. Flameless atomic absorption (FAA) with a pyrolytic graphite furnace was used to analyze titanium in semiconductor grade silicon. Because of its tendency to form TiC, titanium is one of the most difficult elements to analyze. Nevertheless, FAA works well with nanogram amounts of Ti. The adiabatic reaction temperature in SiF_4-Na reactions was calculated for various mixtures of the reactants. In terms of weight, sodium is better than SiF_4 as a heat sink. Below 1000K, however, SiF_4 is a sufficiently effective heat sink.

56040 (ERDA/JPL/954521—77/2) **Integral glass encapsulation for solar arrays. Quarterly progress report No. 4, May 1977.** Kirkpatrick, A.R.; Younger, P.R.; Kreisman, W.S. (Jet Propulsion Lab., Pasadena, Calif. (USA)). May 1977. Contract NAS-7-100-954521. 39p. Dep. NTIS, PC A03/MF A01.

This is the fourth quarterly report under a program to develop integral glass encapsulation for solar cell arrays. The report describes the status of development to establish techniques for employing electrostatic bonding in conjunction with terrestrial solar cells.

56041 (ERDA/JPL/954559—77/1) **Solar silicon via improved and expanded metallurgical silicon technology. Quarterly report, No. 3.** Hunt, L.P.; Dosaj, V.D.; McCormick, J.R. (Dow Corning Corp., Hemlock, Mich. (USA)). Apr 1977. Contract NAS-7-100-954559. 40p. Dep. NTIS, PC A03/MF A01.

The goal of this program is to produce solar-cell-grade silicon at 3000 Mt/y for less than $10/kg by 1986.The approach is to improve the quality of the 200,000-Mt/y process for producing $1/kg, 98-percent pure metallurgical silicon. High-purity sources of quartz and quartzite have been identified for smelting with charcoal in an upgraded arc furnace. Typical quartz analyses indicate Al = 30 ppm, B <1 ppM, Fe = 30 ppM, and P <10 ppM. Charcoal purification by halogen treatment at 1500 - 2500°C reduces impurity levels to less than, or near, 10 ppM. Trade-off studies between charcoal smeltability and impurity contribution to silicon must be determined. It was demonstrated that impurity segregation during Czochralski crystal growth is just as effective when pulling a polycrystalline ingot as when pulling a single-crystalline ingot, provided that constitutional supercooling is prevented. This permits improved silicon yield in the overall process. A Czochralski ingot pulled from upgraded arc-furnace silicon was analyzed at the 65-percent-of-the-melt-pulled point and found to have transition metal impurity concentrations below 0.003 - 0.01 ppMa limits of detection. Estimates of actual transition metal concentrations indicate that the material

should meet or exceed anticipated definitions of solar-grade silicon. Segregation of impurities has been demonstrated using the potentially high-capacity Bridgman technique of crystal growth.

56042 (ERDA/NASA/1022—77/10) **Real time outdoor exposure testing of solar cell modules and component materials.** Anagnostou, E.; Forestieri, A.F. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Apr 1977. Contract EX-76-A-29-1022. 14p. (NASA-TM-X—73655). Dep. NTIS, PC A02/MF A01.

Plastic samples, solar cell modules and sub-modules have been exposed at test sites in Florida, Arizona, Puerto Rico and Cleveland, Ohio, in order to determine materials suitable for use in solar cell modules with a proposed 20-year lifetime. Various environments have been encountered including sub-tropical, sub-tropical with a sea air atmosphere, desert, rain forest, normal urban, and urban-polluted. The samples have been exposed for periods up to six months. Materials found not suitable were polyurethane, polyester, Kapton, Mylar and UV-stabilized Lexan. Suitable materials were acrylic, FEP-A and glass. The results of exposure of polyvinylidene fluoride were dependent on the specific formulation but several types appear suitable. RTV silicone rubber (clear) appears to pick up and hold dirt both as a free film and as a potting medium for modules. The results indicate that dirt accumulation and cleanability are important factors in the selection of solar cell module covers and encapsulants.

56043 (ERDA/NASA/1022—77/13) **Effects of outdoor exposure on solar cell modules in the ERDA/NASA Lewis Research Center Ststems Test Facility.** Weinberg, I.; Curtis, H.B.; Forestieri, A.F. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Apr 1977. Contract EX-76-A-29-1022. 18p. (NASA-TM-X—73657). Dep. NTIS, PC A02/MF A01.

Solar cell modules were removed from the ERDA/NASA Lewis Research Center Systems Test Facility and I-V curves obtained in the Lewis pulsed xenon simulator under standard conditions (air mass 1 and 28°C). Modules involved were supplied by three vendors under the ERDA/JPL Low Cost Silicon Solar Array Project. Outdoor exposure times varied from 41 to 245 days. The effects of outdoor exposure were determined by comparing standard I-V data obtained for the as-received modules with similar data obtained after removal from the field and cleaning with detergent solution. All modules measured in this way exhibited nonrecoverable degradation in P/sub max/ varying from 4 to 7% and I/sub sc/ varying from 2½ to 5½%. One module exposed for 41 days exhibited partial cell discoloration, loss of front surface metallization over the discolored portion, and a decrease in P/sub max/ of 7%, tentatively attributed to cell damage. Measurements before and after cleaning showed a recoverable degradation due to dirt accumulation. This recoverable loss in power was 11% after 245 days in the field for one brand of module, 6% after 48 days for another brand, and 4½% for the third brand.

56044 (TID—27697) **Advances in the development of efficient thin film CdS/Cu_2S solar cells.** Barnett, A.M.; Rothwarf, A. (Delaware Univ., Newark (USA). Inst. of Energy Conversion). Nov 1976. Contract EX-76-C-01-2538. 12p. Dep. NTIS, PC A02/MF A01.

Thin film photovoltaic cells based on cadmium sulfide/copper sulfide have been developed which have energy conversion efficiencies in direct sunlight up to 7.8 percent. These high efficiency cells were based on an analysis of the losses in the 6.8 percent cells previously fabricated. Basic cell design changes were incorporated to reduce these losses. This analysis predicts the design changes, materials improvement, and technology necessary to fabricate thin film cadmium sulfide photovoltaic cells of almost 10 percent energy conversion efficiency in direct sunlight.

56045 **Review: silicon solar cells for terrestrial applications.** Rouse, L.M. (Mater and Energy Res Cent, Tehran, Iran). *J. Mater. Sci.;* **12**: No. 3, 602-615(Mar 1977).

The ways in which silicon solar cells can be designed to give maximum efficiency are reviewed. It is suggested that, although the reduction of processing costs is an extremely important objective of the development programme aimed at widespread application in highly developed countries, the improvement of design might have sufficient cost benefit even if based on current processing technology for the application of solar cells in remote localities which are not easily served with electricity via transmission lines. 83 refs.

56046 **Solar cells using discharge-produced amorphous silicon.** Carlson, D.E.; Wronski, C.R. (RCA Lab, Princeton, NJ). *J. Electron. Mater.;* **6**: No. 2, 95-106(Mar 1977).

Thin film solar cells, 1 μm thick, have been fabricated in p-i-n and Schottky barrier structures using d.c. and r.f. glow discharges in silane. Conversion efficiencies in the range of 2.5 to 4.0% have been obtained with both structures. The p-i-n cells exhibit built-in potentials of 1.1 V while the Pt Schottky barrier cells have barrier heights of 1.1 eV. The dark currents in the p-i-n cells appear to be recombination-limited while the Schottky barrier cells exhibit near-ideal diode characteristics with diode quality factors near unity. 11 refs.

56047 **Heterojunction solar cells of SnO_2/Si.** Franz, S.; Kent, G.; Anderson, R.L. (Syracuse Univ, NY). *J. Electron. Mater.;* **6**: No. 2, 107-123(Mar 1977).

Heterojunction solar cells (HJSC's), fabricated by electron beam evaporation of SnO_2 films onto monocrystalline and polycrystalline Si substrates, show conversion efficiencies as high as 9.9%, fill factors of 0.64, and open circuit voltages of 525 mv under AM1 simulated irradiation. The SnO_2, an n-type semiconductor, acts as a transparent window to solar irradiation and as an antireflection coating of the Si, and it provides the band bending in the Si necessary for photovoltaic conversion. The SnO_2 films, nominally 50 nm thick, have conductivities of the order of $10^3(\Omega\text{-cm})^{-1}$ so that the film makes a good electrical contact between the junction and the metallic front contacts. Measurements of C^{-2}-V and I-V characteristics are consistent with heterojunction theory, and the data imply an electron affinity of the SnO_2 of approximately 0.8 eV greater than the electron affinity of Si. This value limits the open circuit voltage of HJSC's made on p-type substrates to values too small for useful photovoltaic conversion. The predominant dark current mechanism of units of n-type substrates at room temperature and forward bias in the range of 0.3-0.5 v is electron-hole recombination in the transition region. The experimentally determined activation energy is 0.51 ev, approximately E$sub g$/2. At forward voltages below 0.3 v, multistep tunneling via interband states predominates. The photocurrent apparently depends on interface states through which the photogenerated holes in the Si recombine with electrons in the SnO_2. 11 refs.

56048 **Silicon solar cells using natural inversion layers found in thermally-oxidized p-silicon.** Salter, G.C.; Thomas, R.E. (Carleton Univ, Ottawa, Ont). *Solid-State Electron.;* **20**: No. 2, 95-104(Feb 1977).

Very shallow junctions are predicted theoretically with high electric fields in a direction to aid the collection of carriers generated by light of ultra-violet wavelengths. Collection efficiency calculations show the inversion layer cell to be less sensitive to lifetime and surface recombination velocity variations than diffused junction cells. The contact grid, specially designed to minimize the effect of the high inversion layer sheet resistance, produced a total shading of 16%. Illuminated I-V measurements confirm the induced junction to be near ideal, with an ideality factor A 1.05 and a reverse saturation current approaching that predicted theoretically. Conversion efficiencies of 8% have been obtained. 24 refs.

56049 **Analysis of silicon solar cells with stripe geometry junctions.** Hu, C.; Edelberg, J. (MIT, Cambridge, Mass). *Solid-State Electron.;* **20**: No. 2, 119-123(Feb 1977).

The base region collection efficiency is insensitive to the transmissivity of the electrode and/or the diffused layer but quite sensitive to the width and separation of the stripe junctions. The additional losses of carriers are mainly due to the increased bulk recombination rather than the surface recombination. In one case analyzed the collection efficiency decreases by 22% when the junctions are separated by about one sixth of the diffusion length with the surface recombination velocity at 300 cm/sec. Possible uses of the stripe-junction design in p-n junction cells and Schottky barrier cells are re-examined in the light of the new calculation and found to be less attractive than previously suggested.

56050 **High efficiency n-CdS/p-InP solar cells prepared by the close-spaced technique.** Yoshikawa, A.; Sakai, Y. (Tokyo Inst of Technol, Jpn). *Solid-State Electron.;* **20**: No. 2, 133-137(Feb 1977).

Heterojunction solar cells have been made by epitaxial growth of CdS on rho-type InP using the close-spaced technique. Good rectification and photovoltaic properties have been observed in the cells grown on he (110) face of InP. The characteristics of the most efficient cell are V$sub $varies directly as$$=807 mV, the fill factor=0.74 and the power conversion efficiency=14.4% under the solar input of 77 mW/cm$sup 2$. The photovoltaic properties of the cells obtained in this experiment are better than those reported elsewhere, and this is attributed to the superiority of the growth system to those of others in points that the junction is formed at relatively high temperature in a short time. 20 refs.

56051 **Fabrication of thin film Cu_2S/CdS solar cells by a novel evaporation technique.** Das, S.R.; Nath, P.; Banerjee, A.; Chopra, K.L. (Indian Inst of Technol, New Delhi). *Solid State Commun.;* **21**: No. 1, 49-51(Jan 1977).

The fabrication of Cu_2S/CdS heterojunction solar cells of reasonable efficiency utilizing stable Cu_2S films obtained by a solid state reaction between CuCl and CdS films is described. Both the novel technique and the cell geometry used overcome many of the degradation effects commonly encountered in such cells prepared by the conventional chemiplating method.

56052 **Determination of the diffusion length of nonbasic carriers in the base of silicon solar cells.** Bordina, N.M.; Golovner, T.M. (All-

Union Inst of Curr Sources, USSR). *Geliotekhnika;* No. 1, 11-16(1977). (In Russian).

Methods of determination of the diffusion length of nonbasic carriers (L) in the base of a thin silicon solar cell by its spectral sensitivity are considered. Graphs are presented which permit determination of L by the coefficient of carrier collection at long wave illumination (0.95 and 1.0 mum) and by the solar cell thickness. It is shown that, with an open rear surface of the base and a low rate of recombination on it, determination of L becomes considerably simplified if the solar cell is illuminated from the rear side. Experimental data are presented.

56053 Determination of parameters of the current-versus-voltage characteristic of solar cells. Bordina, N.M.; Zaitseva, A.K.; Strel'tsova, V.I. (All-Union Inst of Curr Sources, USSR). *Geliotekhnika;* No. 1, 17-23(1977). (In Russian).

The effect of solar cell parameters, such as the successive resistance R/sub s/, shunt resistance R/sub sh/ of the reverse current I, and of the preexponential multiplier A, on the course of the loading part of the current-voltage characteristic in the working region is considered. A method of determination of these parameters relying on measurements of the short-circuiting current I/sub sc/ and idling stroke voltage U/sub is/, under three kinds of illuminances, is presented. Conditions are stated under which this method is applicable.

56054 Method of determination of operational values of electrical parameters of solar batteries. Bordina, N.M.; Koval'skii, V.Ya. (All-Union Inst of Curr Sources, USSR). *Geliotekhnika;* No. 1, 24-27(1977). (In Russian).

A theoretical and experimental method of determination of operational values of electrical parameters of solar batteries is described. It is based on statistical modeling. By means of selection of the intensity of imitator radiation, it permits reduction of the error due to the discrepancy between the spectral and angular characteristics of imitator radiation and the characteristics of the Sun, to practically insignificant values.

56055 Utilization of transparent heat reflecting coatings in solar energy converters. Koltun, M.M.; Faiziev, Sh.A. (Phys-Tech Inst im. S.V. Starodubtsev, Acad of Sci of the Uzb SSR). *Geliotekhnika;* No. 1, 28-31(1977). (In Russian).

Optical characteristics of dielectric-metal-dielectric coatings, developed by the authors, on glass and polymer films are described. The possiblity of utilization of ZnS-Ag-Zns coatings in solar energy converters is considered. 11 refs.

56056 Solar cells from polysilicon rods. Martinez, J.; Alonso, B.; Criado, A.; Piqueras, J. (Univ Auton de Madrid, Spain). *Electron. Lett.;* **12**: No. 25, 671-672(9 Dec 1976).

The photovoltaic properties of p-n junctions made from l-pass zone melting polycrystalline silicon rods are presented. This solution is considered as an intermediate step for similar cells, but from semielectronic grade polysilicon material. Efficiencies of up to 5.6% have been obtained, even without antireflection coatings. 9 refs.

56057 Polycrystalline silicon solar cells on metallurgical silicon substrates. Chu, T.L.; Singh, K.N. (South Methodist Univ, Dallas, Tex). *Solid-State Electron.;* **30**: No. 12, 837-841(Dec 1976).

Silicon p-n junction structures with various dopant profiles have been deposited on polycrystalline metallurgical silicon substrates, and the characteristics of the resulting solar cells have been evaluated. The experimental procedures and results are discussed.

56058 Gas stream thermal cycling apparatus. Larue, J.C. (Eur Space Res and Technol Cent, Noordwijk, Neth). *J. Phys., E (London);* **9**: No. 10, 890-893(Oct 1976).

A thermal cycling apparatus is developed in which rapid thermal exchange is achieved by circulation of warm and cold gas streams. This principle is compared to other operational apparatus using a liquid transfer medium or radiative heat transfer in vacuum. In the small prototype realized, solar cells are cycled between +130 and -190°C with a rate of temperature change of 250°C min^{-1} at 0°C. On transistor cases the rates of change vary from 250°C min^{1} for a TO 18 to 40°C min^{-1} for a TO 63. Improvements and suggestions for the building of apparatus of greater capacity are given.

56059 Sharing the Sun: solar technology in the seventies. Volume 6. Photovoltaics and materials. Contains sections 7 and 12. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976). 360p. (CONF-760842—P6).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

The 27 papers and 5 abstracts of papers presented were indexed separately for ERDA Energy Research Abstracts. (WHK)

56060 Solar cells for terrestrial applications. Hovel, H.J. (IBM Corp., Yorktown Heights, NY). pp 1-21 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

A review is given of solar cells for terrestrial applications. There are four major categories of cells: silicon, cadmium sulfide, devices for sunlight concentration, and thin film cells. Each of these is discussed in turn, and the most recent results are cited. (87 references)

56061 EFG growth of silicon ribbon for solar cells. Ravi, K.V.; Mlavsky, A.I. (Mobil Tyco Solar Energy Corp., Waltham, MA). pp 23-33 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

A review of the status of the "Edge-Defined, Film-Fed Growth (EFG)" process for producing ribbon-shaped crystals of silicon is presented. A discussion of equipment, process, and cost considerations is followed by an examination of the electrical and structural quality of the material. The performance characteristics of solar cells made from state-of-the-art ribbon crystals are also discussed.

56062 Development of low-cost silicon crystal growth techniques for terrestrial photovoltaic solar energy conversion. Zoutendyk, J.A. (California Inst. of Tech., Pasadena). pp 34-47 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

Because of the growing need for new sources of electrical energy, photovoltaic solar energy conversion is being developed. Photovoltaic devices are now being produced mainly from silicon wafers obtained from the slicing and polishing of cylindrically shaped single crystal ingots. Inherently high-cost processes now being used must either be eliminated or modified to provide low-cost crystalline silicon. Basic to this pursuit is the development of new or modified methods of crystal growth and, if necessary, crystal cutting. If silicon could be grown in a form requiring no cutting, a significant cost saving would potentially be realized. Therefore, several techniques for growth in the form of ribbons or sheets are being explored. In addition, novel techniques for low-cost ingot growth and cutting are under investigation.

56063 Design considerations of solar arrays for terrestrial applications. Ross, R.G. Jr. (Jet Propulsion Lab., Pasadena, CA). pp 48-56 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

The use of photovoltaic solar arrays for terrestrial applications poses a number of unique requirements which must be addressed by the array designer and user. The requirements result from the physical characteristics of photovoltaic devices, the nature of typical terrestrial photovoltaic applications, the demands of the terrestrial environment, and the competitive forces associated with the terrestrial power supply market. Various terrestrial array requirements and design considerations are discussed both in terms of the current state-of-the-art and in terms of the goals of the U.S. National Photovoltaics Program. Included are discussions of the relative performance of various array module designs currently on the market together with thoughts for further design improvements.

56064 Large area Czochralski silicon for solar cells. Rea, S.N.; Wakefield, G.F. (Texas Instruments Inc., Dallas). pp 57-66 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

A detailed model of a typical Czochralski silicon crystal puller is utilized to predict maximum crystal growth rate as a

function of various furnace parameters. Results of this analysis, when combined with multiblade slurry sawing, indicate that the Czochralski process is highly attractive for achieving near-term cost reduction of solar cell silicon.

56065 Low energy production processes in manufacturing of silicon solar cells. Kirkpatrick, A.R. (Simulation Physics, Inc., Burlington, MA). pp 67-72 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

Ion implantation and pulsed energy techniques are being combined for fabrication of silicon solar cells totally under vacuum and at room temperature. Simplified sequences allow very short processing times with small process energy consumption. Economic projections for fully automated production are excellent.

56066 Status of the ERDA photovoltaic materials and device studies. Warschauer, D.M. (Energy Research and Development Administration, Washington, DC). pp 73-78 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

The current ERDA photovoltaic materials and device studies are reviewed in the context of other parts of the national program. Concepts for new methods of reviewing progress and for entertaining unsolicited high technology proposals are presented, along with some other ideas anticipated to receive attention in the near future.

56067 Extension of the Hottel-Whillier-Bliss model to the analysis of combined photovoltaic/thermal flat plate collectors. Florschuetz, L.W. (Arizona State Univ., Tempe). pp 79-92 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

The well known Hottel-Whillier-Bliss model for thermal analysis of flat plate collectors is extended to the analysis of combined photovoltaic/thermal collectors in a manner, such that, with simple modification of the conventional parameters of the HWB model, all of the existing relations and supporting information available in the literature still apply. Beyond the basic assumptions of the original HWB model, it is only necessary to assume that the local photovoltaic cell conversion efficiency is a linear decreasing function of the local cell temperature over the operating temperature range of the combined collector. Based on the extended model, examples of both thermal and electrical performance of the combined collector as a function of collector design parameters are presented and discussed.

56068 Terrestrial concentrating photovoltaic power system studies. Evans, D.L.; Florschuetz, L.W. (Arizona State Univ., Tempe). pp 93-105 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

Studies aimed at defining the role of sunlight concentration in reducing the cost of electrical energy generated by terrestrial photovoltaic systems are described. These studies use computer modeling to (a) compare silicon cells and gallium arsenide cells in concentrating systems, (b) investigate the operation of photovoltaic systems in low insolation locations and (c) evaluate the effect of wind dependent thermal conductances on performance of passively cooled systems. Optimum fixed energy costs occur at higher aperture to cell area ratios for GaAs systems compared to silicon systems due to the better high temperature performance and increased costs of GaAs. Results based on currently available data show that concentrating systems should not be ruled out relative to fixed flat unconcentrated arrays even for low solar irradiation locations such as Cleveland. The wind dependent thermal conductance studies show that for precise modeling the effect of wind speed should be considered in locations having large wind speed deviations from the yearly mean. However, with the present uncertainties in cost inputs, the use of average values is quite appropriate.

56069 Initial production of CdS photovoltaic products. DiZio, S.F. (SES, Inc., Newark, De). pp 108-112 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

A brief, general overview of the present SES product and production plans is presented. SES is in the process of installing a commercial production line for producing a modular integrated cadmium sulfide solar array. Individual standard modules can be interconnected into larger modular arrays which can be expanded to meet individual customer requirements. The basic manufacturing process is shown. The major starting materials are a proprietary substrate, high purity cadmium sulfide powder, plastic sheet, and standard, soda-lime float glass. Integrated patterns are formed on the substrate and also in the process of fabricating the grid. Cadmium sulfide is deposited on the patterned substrate using a large-scale vacuum deposition technique. The copper sulfide junction is formed on the cadmium sulfide by a wet chemistry process.

56070 CdS/Cu_xS solar cells: a low-cost thin film polycrystalline photovoltaic device for terrestrial applications. Meakin, J.D.; Baron, B.; Boeer, K.W.; Burton, L.; Devaney, W.; Hadley, H. Jr.; Phillips, J.; Rothwarf, A.; Storti, G.; Tseng, W. (Univ. of Delaware, Newark). pp 113-119 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

The conversion efficiency of cadmium sulfide solar cells has shown progressive improvement and now exceeds 7½%. The structure and operation of the cell is now sufficiently well understood that cells can be produced reliably and the potential for further improvement in efficiency assessed. Improved gridding procedures allow adjustment of the copper sulfide stoichiometry to give maximum short circuit current without loss in fill factor or open circuit voltage. The achievable efficiency of the CdS/Cu_xS cell is assessed and the potential for further improvement by utilization of mixed zinc cadmium sulfides presented.

56071 Basic mechanisms governing solar-cell efficiency. Lindholm, F.A. (Univ. of Florida, Gainesville); Neugroschel, A.; Sah, C.T. pp 120-129 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

The efficiency of a solar cell depends on the material parameters appearing in the set of differential equations that describe the transport, recombination, and generation of electrons and holes. The many basic mechanisms occurring in semiconductors that can control these material parameters are described. 26 references.

56072 CdS/Cu_xS heterojunction model. Boeer, K.W. (Univ. of Delaware, Newark). pp 130-149 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

The current-voltage characteristics of a CdS/Cu_xS solar cell is explained in terms of the contributing physical effects. These are minority carrier generation, recombination and diffusion in Cu_xS, a Schottky barrier layer with sliding boundary condition, n/sub x=0/ (j), at the junction interface for applied voltages near V/sub oc/ and current saturation due to high field domains at voltages below V/sub oc/-0.2V. These domains may limit the currents to values below the saturation current in the Cu_xS part of the cell. The proposed model shows substantially better agreement with the experiment than the previously used diode model.

56073 $CuInSe_2$/CdS thin film solar cells. Kazmerski, L.L. (Univ. of Maine, Orono). pp 150-158 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

The fabrication and characterization of several thin film p-$CuInSe_2$/n-CdS heterojunction solar cells are presented. Two modes

of operation, involving illumination either through the $CuInSe_2$ or the CdS layer, are discussed. Efficiencies in the range 4 to 5% are reported and the spectral response characteristics are presented for these heterojunctions. The forward J—V characteristics indicate the domination of the generation-recombination mechanism. Device parameters (V/sub oc/, I/sub sc/, FF and eta) are summarized.

56074 Use of solid-dielectric compound parabolic concentrators with photovoltaic devices. Goodman, N.B.; Ignatius, R.; Wharton, L.; Winston, R. (Univ. of Chicago). pp 325-330 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

Prototype solid dielectric compound parabolic concentrators have been made and tested. By means of the geometry and refractive properties of a transparent solid they provide a technique for increasing the power output of silicon solar cells exposed to the sun by an amount equal to the increase in effective collecting area. The response is uniform over a large angle which eliminates the necessity of diurnal tracking of the sun. The technique can be applied to the construction of thin panels and has the potential for significantly reducing their cost per unit area.

THERMIONIC AND THERMOELECTRIC CONVERSION

56075 Schottky solar cells on thin epitaxial silicon. Anderson, W.A.; Vernon, S.M.; Mathe, P.; Lalevic, B. (Rutgers Univ, New Brunswick, NJ). *Solid-State Electron.;* **19**: No. 12, 973-974(Dec 1976).

Schottky solar cells fabricated on 10, 20 and 30 μm epitaxial silicon produce a current density ranging from about 10-22 mA/cm^3, depending on Si thickness and orientation, in close agreement with theoretically predicted data. These results are also in close agreement with recent data on p-n solar cells, using thin epitaxial silicon. Data reported herein predict that 10% efficient Schottky solar cells could be produced using about 20 μ of silicon on a suitable substrate. A 7.6% efficient Schottky solar cell on epitaxial silicon has been recently fabricated and tested using AM1 sunlight (100 mW/cm$sup 2$).

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 55994, 56170

PHOTOVOLTAIC POWER PLANTS

56076 (N—77—16442) Initial technical, environmental, and economic evaluation of space solar power concepts. volume 1: summary. (National Aeronautics and Space Administration, Houston, Tex. (USA). Lyndon B. Johnson Space Center). 31 Aug 1976. 129p. (NASA-TM-X—74309; JSC—11568-V-1). NTIS PC A07/MF A01.

The research concerning the use of large solar power satellites in geosynchronous orbit to beam energy to collection stations on earth is summarized.

56077 (N—77—16443) Initial technical environmental, and economic evaluation of space solar power concepts. volume 2: detailed report. (National Aeronautics and Space Administration, Houston, Tex. (USA). Lyndon B. Johnson Space Center). 31 Aug 1976. 908p. (NASA-TM-X—74310; JSC—11568-V-2). NTIS PC A99/MF A01.

The SPS concepts which appear to be technically feasible are discussed in terms of the economic viability and competitive costs with other energy sources. The concepts discussed include: power station, microwave reception and conversion, space construction and maintenance, space transportation, and program costs and analysis. The conclusions presented include: (1) The maximum output of an individual microwave transmission link to earth is about 5 GW. (2) The mass of 10 GW SPS is between 47,000,000 and 124,000,00 kg. (3) The silicon solar cell arrays make up well over half the weight and cost of the satellite. (4) The SPS in equatorial orbit will be eclipsed by the earth and by other satellites.

56078 Photovoltaic system performance, applications and prospects for economic viability in central utility networks. Schueler, D.G.; Marshall, B.W. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.;* **26**: 1(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 56093, 56151, 56154, 56156, 56157, 56158, 56161

56079 (EPRI-ER—434(6-77)) **Preliminary system analysis of a fixed mirror solar power central station. Final report.** Russell, J.L. Jr.; Eggers, G.; Emrich, W.; Openshaw, F.; Walker, W. (General Atomic Co., San Diego, Calif. (USA)). Jun 1977. 74p. Dep. NTIS, PC A04/MF A01.

As part of the Electric Power Research Institute (EPRI) solar thermal program objectives to evaluate alternative distributed receiver systems, EPRI has contracted with General Atomic Company (GA) to perform a preliminary systems design and evaluation of their fixed mirror solar concentrator (FMSC). In order to assist in this evaluation, a computer program was written to model a preliminary system definition of a power plant design for an FMSC. Analytical models were developed to simulate the performance and to model the cost of subsystems using both heat transfer salt (marketed as "Hitec") and carbon dioxide gas (CO_2) as the primary heat transfer fluids. It was found that the cost of the Hitec system was about one-half that of the CO_2 system. The computer code was exercised to obtain preliminary plant cost estimates and data on the sensitivity of the plant cost to changes in design parameters. Because of limited funding, the results derived in this study are limited and preliminary and were used to indicate trends in cost sensitivity.

56080 (N—77—16447) **Space-based power conversion and power relay systems: preliminary analysis of alternate systems. Interim report, 8 Jul. 1975 - 26 May 1976.** (Boeing Aerospace Co., Seattle, Wash. (USA)). 26 May 1976. Contract NAS8-31628. 309p. (NASA-CR—150171). NTIS PC A14/MF A01.

The results are presented of nine months of technical study of non-photovoltaic options for the generation of electricity for terrestrial use by satellite power stations (SPS). A concept for the augmentation of ground-based solar power plants by orbital sunlight reflectors was also studied. Three SPS types having a solar energy source and two which used nuclear reactors were investigated. Data derived for each included: (1) configuration definition, including mass statement; (2) information for use in environmental impact assessment; (3) energy balance (ratio of energy produced to that required to achieve operation), and (4) development and other cost estimates. Cost estimates were dependent upon the total program (development, placement and operation of a number of satellites) which was postulated. This postulation was based upon an analysis of national power capacity trends and guidelines received from MSFC.

56081 Report on solar thermal power systems and their potential for utility applications. Watson, M.; Katz, E.L.; Bruce, R.W. (Aerospace Corp., Los Angeles). *Trans. Am. Nucl. Soc.;* **26**: 1(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56082 Astronautical energy solution. *Spaceflight;* **19**: No. 3, 82-89(Mar 1977).

The possibility of using a satellite in geosynchronous orbit to collect solar energy and transmit it to the earth in the form of microwave beams is discussed. A heat engine converter is proposed in which sunlight would be concentrated by the collector into a cavity, providing heat for a set of helium gas turbines. The satellite's alternators would be driven by Brayton cycle turbines typical of present-day jet aircraft. But, unlike a jet's turbine which vents off fuel-heated air after it turns the engine's fan, the Powersat turbine would use the sun as its only fuel and would operate on a closed loop. Helium would be heated in the cavity, pass through the turbines, then flow through a space radiator where the helium's heat would be rejected. The helium then would return to the cavity to begin the cycle again. Electric power is routed to a phased array RF generator, where it is converted to a narrow microwave beam at 2450 Mhz by high-efficiency crossed-field amplifiers (amplitrons). The beam can be directed to any desired load point visible from the satellite, which appears stationary relative to the earth's surface. At the load point, the power beam is reconverted to dc electric power by a fixed receiving antenna about five miles in diameter. A grid interface converter changes the dc power to 60 Hz high voltage ac.

56083 Utilization of solar radiation at large solar power plants with hydraulic storage. Aparisi, R.R.; Teplyakov, D.I. (State Power Eng Inst im. G.M. Krzhizhanovskii, USSR). *Geliotekhnika;* No. 1, 3-10(1977). (In Russian).

As a result of specific conditions of getting solar radiation, there arises the problem of storage of the energy produced at solar power plants. To solve this problem, it is necessary to provide not only for daily, but also seasonal and even annual storage volumes. Among different alternatives, the systems of the so-called hydraulic storage stand out. They comprise, in principle, the main elements of a complex ensuring development of production and faovrable condi-

tions for human life (energy, water). Owing to the adequately developed and extensive power systems, solar power plants do not necessarily have to be built in the immediate vicinity of dams of hydroelectric power plants. It is enough that they operate within a general electric power system.

56084 Conjugated cycles of single-loop solar energy refrigerating plants. Grilikhes, V.A.; Evseev, V.S.; Chikovani, V.V. *Geliotekhnika;* No. 1, 50-58(1977). (In Russian).

The possibility of realization of more than one thermodynamic cycle in single-loop thermal power plants is considered from general topological and thermodynamic aspects. Methods of organization of conjugated cycles are pointed out. Common features of utilization of conjugated cycles in solar energy refrigerating plants and in radiant energy concentrators with radiation heat removal into the environment are shown. 17 refs.

CENTRAL RECEIVER

56085 (COO—2823-1) **Preliminary test report, 10 KWt solar energy receiver. Test period, July 31, 1976—August 27, 1976.** (Sanders Associates, Inc., Nashua, N.H. (USA)). Oct 1976. Contract EY-76-C-02-2823. 31p. Dep. NTIS, PC A03/MF A01.

Under contract to the Energy Research and Development Administration (ERDA), Sanders Associates is developing a solar receiver/heat exchanger unit for use in advanced solar powered electric generation plants. The function of the receiver is to absorb the concentrated solar energy focused on it by a large mirror field and to transfer this energy to an air stream, heating the stream to temperatures suitable for efficient operation of air-turbine (Brayton cycle) powered generators. The preliminary results of the test program during which the first reduced power (10 KWt) model of such a receiver was tested at the solar test facility, White Sands, New Mexico, are reported.

56086 (SAND—77-8243) **Tower design considerations for the solar thermal central receiver systems.** Murphy, L.M. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1977. Contract EY-76-C-04-0789. 27p. Dep. NTIS, PC A03/MF A01.

Some basic design considerations for concrete solar thermal power towers are described. Seismic disturbances are of primary concern for the large towers being proposed for some commercial systems. For the larger receiver/tower systems the tower top accelerations due to seismic disturbances are not significantly amplified. However, the attachment of the more massive receivers may become more difficult for the larger systems.

56087 Coming: solar power plants. Murphy, L.M.; Skinrood, A.C. (Sandia Lab, Livermore, Calif). *Mech. Eng.;* **98**: No. 11, 26-32(Nov 1976).

ERDA (Energy Research and Development Administration) presently has the U.S. government responsibility for funding and developing a solar central receiver thermal power system for generating electricity. The operation of a 5-MW(th) solar test facility is scheduled for operation in 1977; a 10-MW(e) pilot plant is scheduled for 1980. This latter plant, the subject of this article, is designed to produce 10 MW of electric power on a clear day. Peak power is substantially more, average power substantially less, than 10 MW(e); about 40 MW(th) are required to produce 10Mw(e). The concept design consists of a field of individually guided and controlled mirrors, called heliostats. They offer a 2-degree-of-freedom focusing system, simulating a very large and steerable Fresnel reflector. The heliostats redirect the sun's energy to a receiver mounted on top of a tower. The receiver absorbs radiant energy in a circulating fluid. It is then either used directly to power a conventional steam turbine generator, or stored for later use. The heliostat concepts being worked out by four contract teams are described, as are the field layouts and receiver tower locations for three of them (one contract is for a heliostat only). Three central receiver designs are also described. Preliminary calculations indicate that roughly 2000 heliostats, each with about 40 mSsup 2$ (430 sq ft) of reflective surface, would be required for the 10-MW(e) pilot plant. The preliminary designs under study all require approximately 100 acres (40 hectares) of land for the 10-MW plant. However, less than 40 percent of this land is actually covered with mirrors. Evaluation of the different systems is to begin in 1977. The thermal storage problem is discussed briefly. 9 refs.

DISTRIBUTED COLLECTOR

56088 (EPRI-ER—434) **Preliminary system analysis of a fixed mirror solar power central station. Final report.** Russell, J.L. Jr.; Eggers, G.; Emrich, W.; Openshaw, F.; Walker, W. (General Atomic Co., San Diego, Calif. (USA)). Jun 1977. 74p. Dep. NTIS, PC A04/MF A01.

A computer program was written to model a preliminary system definition of a power plant design for a fixed mirror solar concentrator. Analytical models were developed to simulate the performance and to model the cost of subsystems using both heat transfer salt (marketed as "Hitec") and carbon dioxide gas (CO_2) as the primary heat transfer fluids. It was found that the cost of the Hitec system was about one-half that of the CO_2 system. The computer code was exercised to obtain preliminary plant cost estimates and data on the sensitivity of the plant cost to changes in design parameters. Because of limited funding, the results derived in this study are limited and preliminary and were used to indicate trends in cost sensitivity.

OCEAN THERMAL GRADIENT POWER PLANTS

REFER ALSO TO CITATION(S) 56170

56089 (CONF-770331—5) **Alternative forms of energy transmission from OTEC plants.** Konopka, A.; Biederman, N.; Talib, A.; Yudow, B. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. Contract EX-76-C-01-2426. 12p. Dep. NTIS, PC A02/MF A01.

From 4. ocean thermal energy conversion conference; New Orleans, Louisiana, United States of America (USA) (22 Mar 1977).

The transmission of OTEC-derived chemical and electrical energy is compared. The chemical energy-carriers considered are the following: gaseous and liquid hydrogen, liquid ammonia, methanol, gasoline, hydrazine hydrate, anhydrous hydrazine, unsymmetrical dimethylhydrazine (UDMH), 1,7-Octadiyne, and tetrahydrodicyclopentadiene. The assessment assumes that each of the above energy carriers were transported by barge and/or pipeline. The delivered costs were then compared with transmission of electricity by submarine cables. Because chemical and electrical energy are not equivalent, however, their comparison can only be done after the outputs are converted to a common form. Thus, in addition to presenting the delivered cost and overall energy efficiency of the chemical energy-carriers, we have provided a discussion of the equipment, costs, and efficiencies of converting the hydrogen and ammonia delivered into electricity, and the electricity delivered into hydrogen and ammonia. A concise technical assessment and economic analysis of components associated with the conversion, storage, transportation, and shore-based receiving facilities for the conversion of OTEC mechanical energy to chemical energy is provided and compared to the conversion and transmission of electrical power. Results concerning the hydrogen and ammonia analysis were determined as part of the OTEC program at IGT from May 1975 through May 1976 under Contract No. NSF-C1008 (AER-75-00033) with the National Science Foundation and ERDA. Information concerning carbonaceous fuels and high-energy fuels production was developed as part of the current IGT OTEC program under Contract No. E(49-18)-2426 with ERDA.

56090 (COO—4041-2) **Heat transfer problems in an ocean thermal power plant.** (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Dept. of Physics; Hawaii Univ., Honolulu (USA). Dept. of Mechanical Engineering). 1976. Contract EY-76-S-02-4041. 6p. (CONF-7606138—1). Dep. NTIS, PC A02/MF A01.

From 12. southeastern seminar on thermal sciences; Charlottesville, Virginia, United States of America (USA) (6 Jun 1976).

The effects of biological fouling on the heat transfer rates for an OTEC heat exchanger are under study. The experimental and mooring arrangements are sketched. The experiment is outlined and some preliminary data are presented. (MHR)

56091 (DSE/2426—12) **Alternative energy transmission systems from OTEC plants. Project 8980 third quarter progress report, January 1—March 31, 1977.** Yudow, B.; Konopka, A.; Biederman, N. (Institute of Gas Technology, Chicago, Ill. (USA)). May 1977. Contract EX-76-C-01-2426. 20p. Dep. NTIS, PC A02/MF A01.

Three types of thermal energy storage media were considered for transport of OTEC energy. They were the following: (1) sensible heat media, which depends upon the heat capacity of the material for energy storage, (2) latent heat of fusion material, and (3) reversible chemical reactions, which depend upon the change in energy content of certain compounds as chemical bonds are broken and other bonds are made. Only those systems operating in the nominal temperature range of 400° to 1000°F were considered. The lower limit of the temperature swing of sensible heat thermal energy systems was approximately 400°F. A literature search was undertaken and completed. As a result of the literature search, four thermal energy transport system concepts were selected and synthesized into conceptual systems that use OTEC energy to charge the thermal storage medium installed in a ship hull, then transport the heat storage system to shore for use, or convert the thermal energy to electricity using a heat engine. The four conceptual designs, of which two used sensible heat storage, one used the latent heat of fusion, and one used a reversible chemical reaction, were derived from thermal energy storage conceptual designs for solar thermal-electric power plants or solar total energy systems. The four thermal energy transport systems were: (1) rock/oil hybrid - a sensible heat storage system using crushed gravel rock and a heat transfer fluid, Caloria HT-43; (2)

HITEC - a sensible heat storage system using a molten salt; (3) sodium hydroxide - a latent heat of fusion system also using sensible heats of liquid and solid phases; and (4) sulfur trioxide/sulfur dioxide - a reversible chemical reaction system using the following reaction: SO_3 + Heat reversible SO_2 + $\frac{1}{2}O2$. Results of a cost/efficiency analysis of the four systems are tabulated and discussed. (WHK)

SOLAR RADIATION UTILIZATION

REFER ALSO TO CITATION(S) 56986

56092 (PB—265105) **Solar energy applications in agriculture: potential, research needs, and adoption strategies.** Bender, F.E.; Cowan, A.M.; Dillon, R.W.; Hansford, J.D. Jr; Hurdis, D.A. (Maryland Univ., College Park (USA). Agricultural Experiment Station). Jan 1976. Contracts USDA-12-14-1605-106;NSF-PTP75-10573. 119p. (A—184). NTIS PC A06/MF A01.

See also PB-255 928.

Objectives pursued in this study are: (1) assessment of present agricultural operations to determine those with potential for use with solar energy; (2) development of recommendations for an overall experimental research program to establish the technical and economic feasibility of using solar energy in agricultural operations; and (3) formulation of recommendations for strategies to achieve adoption of solar energy components and systems in agriculture. Applications of solar energy to the following aspects of agriculture are examined: grain drying, tobacco curing, peanut drying, broiler housing, swine production, farm housing, greenhouses, and irrigation. Current fuel prices for each of the agricultural regions (determined by crop production) are also reviewed.

56093 (SAN/1132—1) **Industrial applications of solar energy. Quarterly report.** (McDonnell Douglas Astronautics West, Huntington Beach, Calif. (USA)). Jan 1977. Contract EY-76-C-03-1132. 255p. Dep. NTIS, PC A12/MF A01.

The objective of this program is to define solar energy systems that are technically and economically feasible, can satisfy all or part of selected industry demands, and to determine the market potential of such systems. (The primary emphasis is being placed on the application of total energy systems where the industrial process heat, electrical demands, and space heating and cooling requirements are satisfied at maximum possible efficiency.) Total energy conceptual designs will be generated for selected industries and ranked for subsequent preliminary design selection. Final rankings will consider preliminary site evaluations as well as utility interfaces. MDAC will also provide ERDA with a total project plan and industrial site selection criteria. Major efforts during this reporting period consisted of extending the program to include all of the United States, continued collection of demand data, selection of an insolation methodology, collector/conversion system trade studies, absorption/vapor cycle refrigeration trades, completion of the resizing of all first level designs, and initiation of the utility interface and market penetration investigation. Energy consumption forecasts for selected SIC groupings have been extended to include all of the U.S.

56094 **Characterization of industrial process heat, including the potential for solar or nuclear systems to supply this market.** Hall, E.H.; Eibling, J.A. (Battelle Columbus Labs., Columbus, OH). *Trans. Am. Nucl. Soc.;* **26**: 2(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56095 **Solar water-raising plant with a diaphragm pump.** Umarov, G.Ya.; Alimov, A.K.; Ovechkin, N.F.; Abidov, T.Z. (Acad of Sci of the Uzb SSR). *Geliotekhnika;* No. 6, 82-83(1976). (In Russian).

A description is presented of a membrane pump with a three-stroke valve for a solar water-raising plant with the capacity of 600 l/hr to a height of 20 m.

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 56026, 56092, 56154, 56162, 56167, 56168

56096 (CONF-770359—1) **Systems approach to solar heating and cooling systems.** Jardine, D.M. (Kaman Sciences Corp., Colorado Springs, Colo. (USA)). 1977. 56p. Sciences Corp., Colorado Springs, CO.

From Energy Environment conference; Kansas City, Missouri, USA (29 Mar 1977).

The following energy systems were tested and their operational characteristics determined for baseline type comparison: (1) direct utilization of stored thermal energy, (2) air-to-air heat pump, (3) fluid-to-air heat pump, and (4) electric resistance heaters to supplement house heating and to add heat to thermal storage during off-peak hours. (MOW)

56097 (COO/2867—1) **Toxicological evaluation of liquids proposed for use in direct contact liquid—liquid heat exchangers for solar heated and cooled buildings.** Buchan, R.M.; Majestic, J.R.; Billau, R. (Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.). Sep 1976. Contract EY-76-S-02-2867. 264p. Dep. NTIS, PC A12/MF A01.

This report contains the results of the toxicological evaluation part of the project entitled, "Direct Contact Liquid-Liquid Heat Exchangers for Solar Heated and Cooled Buildings." Obviously any liquid otherwise suitable for use in such a device should be subjected to a toxicological evaluation. 34 liquids (24 denser than water, 10 less dense) have physical and chemical properties that would make them suitable for use in such a device. In addition to the complexity involved in selecting the most promising liquids from the standpoint of their chemical and physical properties is added the additional difficulty of also considering their toxicological properties. Some of the physical and chemical properties of these liquids are listed. The liquids are listed in alphabetical order within groups, the denser than water liquids are listed first followed by those liquids less dense than water.

56098 (N—77—16446) **The design of a solar energy collection system to augment heating and cooling for a commercial office building.** Basford, R.C. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Jan 1977. 43p. (NASA-TM-X—72753). NTIS PC A03/MF A01.

Analytical studies supported by experimental testing indicate that solar energy can be utilized to heat and cool commercial buildings. In a 50,000 square foot one-story office building at the Langley Research Center, 15,000 square feet of solar collectors are designed to provide the energy required to supply 79 percent of the building heating needs and 52 percent of its cooling needs. The experience gained from the space program is providing the technology base for this project. Included are some of the analytical studies made to make the building design changes necessary to utilize solar energy, the basic solar collector design, collector efficiencies, and the integrated system design.

56099 (SAND—75-5880) **Sandia's solar total energy program.** Leonard, J.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). [nd]. 12p. (CONF-751005—14). Dep. NTIS $4.00.

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

56100 (UMD—4908-8) **CCMS solar energy pilot study. Solar heating and cooling systems in buildings. Report to the CCMS plenary, Duesseldorf, Federal Republic of Germany, February 8—9, 1977.** (Maryland Univ., College Park (USA). CCMS Projects Office). 1977. Contract EY-76-S-05-4908. 10p. Dep. NTIS, PC A02/MF A01.

The Solar Energy Pilot Study's "Report to the CCMS Fall Plenary" in October 1976, contained a detailed account of the annual meeting which had been held shortly before (September 1976) in Copenhagen. That report contained summaries of national solar heating and cooling programs and projects; information on the first reports prepared according to the CCMS System Reporting Format and future similar reports, on the exchange of documents among participating countries, on the formation of a new Mediterranean Climate Applications Group; and additional details on highlights of the meeting and other pilot study activities. Several major accomplishments are briefly reviewed.

56101 **Statistical investigation of the efficiency of solar and evaporative coolers in the conditions of Turkmenia.** Rakhmanov, A.; Khandurdyev, A.; Kakabaev, A.; Goshdzhanov, M.; Annanazarov, M. (Phys-Tech Inst, Acad of Sci of the Turkm SSR). *Geliotekhnika;* No. 1, 59-64(1977). (In Russian).

The statistical relation between specific cooling output of solar and evaporative coolers and meteoparameters of the atmosphere is investigated. Graphic relations are obtained permitting determination of the percentage of availability of the set values of specific cooling output of the plants in question. The calculated values of the pair and multiple correlation permit establishment of a relation between the investigated magnitudes and evaluation of the accuracy of prediction.

56102 **Regional conditions and the possibility of application of low temperature solar heaters in Yakutian mines.** Kim, V.P. (Inst of Phys-Tech Probl of North, Acad of Sci of the USSR, Yakutsk). *Geliotekhnika;* No. 1, 70-75(1977). (In Russian).

The topical interest of the problem of control of thermal conditions in mines situated in permafrost regions is noted. The conditions of application of solar energy installations in Yakutia are considered. Possible variants of solar energy storage in mine rocks are discussed. The higher efficiency of mine air heating by means of

solar air heaters compared with heating by a calorifier is noted. 9 refs.

56103 Solar energy source book. Martz, C.W. (ed.). Washington, DC; Solar Energy Institute of America (1977). 712p.

An organized compilation of solar energy related products and services is provided for the building owner and solar building industry. The categories, products and services, are each subdivided into three sections: (1)the catalog; (2) a listing by state; (3) a listing by title. There is a section on taxes and tax breaks related to a solar system, one which explains how a solar system works and shows how to approximate the amount you should spend on a solar system in various parts of the country, a glossary to explain new terms, and descriptive passages to answer questions about facets of the solar energy field. The material presented was either supplied by or abstracted from information received from the companies and service organizations listed. (MHR)

56104 Solar glass house with subsoil heat accumulator. Khairiddinov, B.; Umarov, G.Ya.; Bardiashvili, A.B.; Sadykov, T.A. (Acad of Sci of the Uzb SSR). *Geliotekhnika;* No. 6, 78-81(1976). (In Russian).

The solar glass house is oriented towards the south. Its useful area is 5 x 25 = 125 m^2. It is insulated with 20 mm board, tar paper, fiber glass 50 mm thick, again tar paper, waste board lathwork, adobe clay, and black polyethylene film. The regenerative heat accumulator is placed under the soil at a depth of 50 cm and consists of a pipe filled with pebbles. The pipe frame is made of 10 mm wire and is wrapped with black polyethylene film. During the day, heated air from the upper part of the glass house is fed to the pebble accumulator by means of a fan. At night, cooled air is passed through this system.

56105 Method for estimating solar heating and cooling system performance. Hittle, D.C.; Walton, G.N.; Holshouser, D.F. (US Army Constr Eng Res Lab, Champaign, Ill). *ASHRAE Trans.;* **82**: 56-65(1976).

A research effort to develop a method for the preliminary determination of the feasibility of heating and cooling buildings with solar energy is described. Computer simulation was employed to perform numerous parametric studies and provide performance curves for two Army buildings at five sites. Using this procedure and more than 200 full-year solar system simulations, the effects of collector area, collector tilt angle, storage tank volume, and heat exchanger effectiveness were examined. Results of these specific studies as well as a method for generalizing these results are presented. 6 refs.

56106 Initial test results for a solar-cooled townhouse in the mid-Atlantic region. Hill, J.E.; Richtmyer, T.E.; Jenkins, J.P. (NBS, Washington, DC). *ASHRAE Trans.;* **82**: 389-404(1976).

The paper presents the results of the first series of cooling tests conducted during the summer of 1975. A townhouse having a floor area of 110 m^2 and located in suburban Washington, DC was equipped with a solar cooling system and tested. The cooling system consisted of 45 m^2 of double-glazed flat-plate collector having a nonselective absorber, a lithium-bromide absorption air-cooling unit designed to be operated using a heated liquid, and a 1.9-m^3 water storage tank. The system was subjected to extensive testing over a 2-week period. 8 refs.

56107 Design of a solar heating system using seasonal heat storage. Hooper, F.C. pp 260-261 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

56108 Solar energy system design approaches for architects. Chiang, R.N.S.; Adams, S.A. (Virginia Polytechnic Inst. and State Univ., Blacksburg). pp 288-297 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

One of the major problems encountered in solar energy system design is the separation of architectural and engineering functions. This is partially due to the lack of an acceptable set of guidelines for architects to follow in the planning and integration of this engineering function. The architect often spends time on functions which whould have been left to the engineer and the engineer is faced with decisions he neither wants nor is qualified to make. The solar energy system is like any of the other buildng system technologies: it must be developed and recycled as more refinements are made in the overall design, with architect estimations being replaced by engineering design. It is intended to identify the decisions which must be made in solar design as well as the level at which they must be made (client, architect, or engineer) and to present approaches and guidelines to aid in those decisions.

56109 Look at vocational training for the solar energy industry. Heath, S.D. (Mitchell-Webb Associates, Inc., San Diego, CA). pp 298-310 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

The primary thrust of this paper is to explore the opportunity for present and prospective tradesmen to become competent in solar system installations and maintenance. A training program which offers a major contribution to overcoming barriers to innovation that might exist in the construction industry is discussed. The purpose and operation of the training must necessarily teach new skills and upgrade present skills in relation to established construction labor classifications. Certain emphasis must also be placed on teaching of the basic theory and technical rudiments related to the installation of solar energy systems. A viable training program must process trainees through structured solar system instruction and at the same time continue to evaluate the trainees' response to solar system exposure. Current employment opportunities must also be under continual evaluation and analysis. A comprehensive look at one training program now in operation in the Southwest United States is discussed. The training facility is operated by the San Diego County Construction Laborers Training and Retraining Trust (a non-profit Taft-Hartley authorized organization). The program provides basic training applicable to the building trades in the installation and maintenance of a wide variety of solar energy systems.

56110 Basic solar energy balance. Groen, J.M. (Dryden Flight Research Center, Edwards, CA). *IF (Ind. Forum);* 7: No. 2-3, 83-86(1976).

The costs of solar energy systems are influenced by the accuracy of the solar energy balance that is aimed for. Factors are/ solar radiation (which is predictable), building loads (which can vary considerably), solar collectors (the performances of which fall within predictable limits), and the HVAC system (where heat-exchanger interface and temperature canconsiderably influence total performance). A building in the Mojave Desert is being retrofitted with a solar energy system.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

REFER ALSO TO CITATION(S) 56092

WATER HEATING

REFER ALSO TO CITATION(S) 56016, 56103, 56107, 56109

56111 (DSE/2531—2) SOLCOST: solar hot water handbook. A simplified design method for sizing and costing residential and commercial solar service hot water systems. (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Solar Energy). Apr 1977. 17p. TIC.

Instructions, examples, and a form for the ERDA SOLCOST service for estimating the sizing and installed costs of solar hot water systems are presented. The SOLCOST service is provided free in responding to the current Solar Hot Water Initiative programs of ERDA. (WHK)

56112 (PB—264151) Solar water heating in dwellings. survey of selected prospective users in sydney. Smith, P.R. (Department of Environment, Housing and Community Development, Canberra (Australia)). Jan 1977. 34p. NTIS, PC A03/MF A01.

Domestic solar hot water systems have been used fairly extensively in Western Australia and the Northern Territory, and more recently in South Australia. However they are little used in Melbourne and Sydney, which might be considered as large potential markets. A survey was undertaken in Sydney to assess the knowledge and views of potential users in relation to solar heating units.

56113 Experimental investigation with artificial sunlight of a solar hot-water heater. Simon, F.F. (Lewis Research Center, Cleveland). pp 350-354 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).
See CONF-760842—P8.

56114 Solar water preheater for use in a cold climate. Chan, W. (Abugov and Sunderland Architect and Engineers, Calgary, Alberta); Colville, S.; Nobbee, C.; Dumont, R.S. pp 336-349 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).
From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).
See CONF-760842—P8.
Material is presented on the feasibility of a domestic hot water preheater using solar energy in a cold climate. The climate area chosen was Saskatoon, Saskatchewan, Canada, (52° N Latitude) with an average annual heating degree-day total of 6040 (Deg. C-days). The solar water preheater chosen for the mathematical simulation and cost estimation consists of a solar collector available from a commercial manufacturer (two glass plates and a non-selective surface, total surface area 3.4 m^2), a hot water storage tank and heat exchanger, and associated pumps, piping and controls, with the solar collector fluid being an antifreeze solution. The feasibility study includes a dynamic mathematical simulation of the system components, including the variation of solar intensity over a 24 hour period and heat storage effects in the preheater-heat exchanger combination. The cost estimates were carried out for two alternative systems; one, an off-the-shelf system and the other a low cost do-it-yourself system. It was concluded that the economics of a solar water installation would be favorable when compared with electricity as the alternative energy source when a low cost solar heater is used. For natural gas heating, however, the economics do not appear to be favourable given present and anticipated fuel costs.

56115 Solar hot water heating system. Shippee, P. (Colorado Sunworks, Boulder). pp 355-365 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).
From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).
See CONF-760842—P8.
One of the most economical uses of solar energy today is domestic hot water heating. This is so because the installed equipment works at nearly full capacity throughout the year to satisfy a relatively constant domestic demand for hot tap water. The selection of a solar mechanical system design is presented here along with fuel cost comparisons, sizing information, specific component selection, and pricing of the solar energy delivered to the faucet. The drain-down system with open solar storage was chosen because of its superior freeze-proof behaviour and potential for low cost and low maintenance. Experience building a long life system for the commercial market with available materials and a necessarily moderate level of technology is the basis for this presentation.

56116 Reinforced pillow solar water heater. Davison, R.P.; Harris, W.B. (Texas A and M Univ., College Station). pp 366-371 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).
From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).
See CONF-760842—P8.
The pillow solar water heater is formed by confining a flexible bag between supporting elements to give it strength to withstand pressure. This narrows the flow channels resulting in a number of advantages. Fabrication details and some performance data are given with some discussion of economic factors and probable applications.

56117 Solar energy and energy conservation in Australian buildings. Sheridan, N.R. (Texas Tech Univ., Lubbock). *IF (Ind. Forum);* 7: No. F, 107-120(1976).
Solar energy is extensively used in Australia for domestic water heating. Installations are extremely simple, working on the thermosyphon principle. Generally, the Australian climate is warmer than in the USA; less energy is used per household and energy costs have not risen dramatically (due to the predominant use of coal-fired generators). Energy conservation can be by non-solar, passive solar, or active solar means. Australian efforts concern the improved design of houses for tropical areas, heat exchange between ventilation and exhaust air, the use of heat pumps and total energy systems, evaporative cooling, and ponded roofs; isolated homesteads present special problems, and it is economically feasible to make them energy-independent through the use of solar energy. Research into improved materials for residential hot-water systems is continuing; some experimental space cooling is also being undertaken. However, government policy on energy conservation is not clearly stated, through some indirect measures have been taken.

OTHER

REFER ALSO TO CITATION(S) 56084

56118 Experimental investigations of solar distilling installations with different film surfaces. Norov, E.Zh.; Dzhuraev, T.D.; Achilov, B.M. (Phys-Tech Inst im. S.V. Starodubtsev, Acad of Sci of the Uzb SSR). *Geliotekhnika;* No. 1, 76-81(1977). (In Russian).
The possibilities of application of polymer films as transparent insulation in portable solar distilling installations are considered. To improve their wettability and transparency in a moist state, the polyethylene films were treated with polyvinyl alcohol. As a result, the wettability and, consequently, productivity of film distilling installations improved. 8 refs.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 56059, 56067, 56074, 56079, 56093, 56105, 56106, 56113, 57012

56119 (COO/2604—76/1) **Heat pipes applied to flat-plate solar collectors. Final report.** Bienert, W.B.; Wolf, D.A. (Dynatherm Corp., Cockeysville, Md. (USA)). May 1976. Contract EY-76-C-02-2604. 60p. (DTM—76-2). Dep. NTIS, PC A04/MF A01.
The objective of this program was to analytically and experimentally investigate the use of heat pipes in flat-plate solar collectors. Heat pipes are passive heat transport devices which utilize a closed evaporation-condensation cycle. Because of their high equivalent conductance, they appear to be well suited to transport heat from the solar absorber to an air or liquid distribution system. The program consisted of the following tasks: (I) Configuration Studies, (II) Parametric Performance Studies, (III) Economic Analysis, (IV) System Integration Studies, (V) Submodule Fabrication and Testing (in the laboratory), and (VI) Full-Scale Module Fabrication and Testing (using solar input). An additional Task VII, Feasibility Study of a Stationary Concentrator, was identified during the program and was also completed. In performing Tasks I through IV, various aspects of integrating heat pipes into flat-palte solar collectors were investigated. The results of these tasks were reported in the Annual Progress Report (Ref. 2) dated January 31, 1975. A summary of that program effort is included in the present report. The results of the experimental work conducted under Tasks V and VI are presented in this report. Under Task V, breadboard heat pipes were fabricated from sections of Roll-Bond panels and their heat transfer performance was evaluated in the laboratory. Three complete solar panels, two of which were heat pipe absorbers and one was a Roll-Bond control panel, were fabricated and solar tested during Task VI. Finally, under the new Task VII, a feasibility study of a stationary concentrator using heat pipes as thermal diodes was conducted. Results are presented and discussed.

56120 (ORO/4927—77/1) **Engineering analysis and testing of water-trickle solar collector, report No. 3. Progress report, June 1975—November 1976.** Beard, J.T. (Virginia Univ., Charlottesville (USA). Dept. of Mechanical Engineering). Jan 1977. Contract EY-76-S-05-4927. 46p. Dep. NTIS, PC A03/MF A01.
An outdoor solar collector testing facility has been built at the University of Virginia for the purpose of conducting thermal performance evaluations of the Thomason "SOLARIS" watertrickle solar collector. The test facility was designed to include the instrumentation and other recommendations of the National Bureau of Standards (1). The facility has been used for simultaneously testing four "SOLARIS" collector panels under different operational conditions of inlet water temperatures and flow rates with the same atmospheric exposure. A near linear relationship of steady-state efficiency for the Thomason "SOLARIS" collector is displayed as a function of the difference between inlet water temperature and the ambient temperature, divided by the incident solar energy. The scatter in the data results from other variables which are analyzed and include glazing cleanliness, angle of incidence and wind. Various glazing materials are also examined and performance curves are presented for the water-trickle collector with a mylar film and "Tedlar" (Dupont registered trademark) PVF film. The performance of the "SOLARIS" water-trickle collector is compared with published results for conventional single and double glazed flat-plate collectors. The test facility has been expanded to evaluate the performance of an open fluid-film (silicone oil) collector designed by Scientific-Atlanta, Inc. Testing will be done at various ambient conditions and results will be compared with those of the water-trickle collectors. An analytical model will be developed and also compared with the

water-trickle model. The next phase of the research will study various design modifications of both collectors. Included will be various glazing designs. The theoretical model of the collectors will be refined to more closely simulate performance.

56121 Design and tests of flat-plate solar collectors. Bernardini, C.; Mandas, N.; Mura, P.; Tola, G. (Univ di Cagliari, Italy). *Termotecnica (Milan);* **31**: No. 2, 76-86(Feb 1977). (In Italian).

This work, which is part of a research plan in solar energy exploitation, deals with the design of three flat-plate solar collectors, sheet and tube type, of equal geometry but of different technology. The collectors have been first tested in an open circuit setup to evaluate the thermodynamic performance of the single absorber. Then, connecting the collectors to a storage tank, with natural circulation, the performance of the whole system has been evaluated. Recording or hourly marking the most important variables and the meteorological parameters, the hourly performances of the single collectors have been evaluated. 11 refs.

56122 Combination of photo cones and photo wedges with radiation receivers. Baranov, V.K. *Geliotekhnika;* No. 1, 32-37(1977). (In Russian).

It is noted that certain features of photo cones and photo wedges, which make it difficult for them to be combined with ordinary radiation receivers, prevent their wide use in solar energy practice. Non-Soviet radiation receivers operating jointly with photo cones and photo wedges are described. In order to minimize the angles of reflected rays from these concentrators, double systems are proposed consisting of photo cones and photo wedges joined by small apertures. The use of double systems is particularly convenient in combination with solar cells whose efficiency decreases at large angles of ray incidence.

56123 Paraboloid-hyperboloid concentrating systems and their precision. Zakhidov, R.A.; Vainer, A.A. (Phys-Tech Inst im. S.V. Starodubtseva, Acad of Sci of the Uzb SSR). *Geliotekhnika;* No. 1, 42-49(1977). (In Russian).

A general method of calculation of distribution of the radiant vector for paraboloid-hyperboloid concentrating systems is given. Precision characteristics of a system with a concave hyperboloid are investigated. It is found that the precision of such a system is virtually completely determined by the precision of the primary mirror. 10 refs.

56124 Aging of silazane protective coating in vacuum. Zakhidov, R.A.; Ismanzhanov, A.; Gribelyuk, I.I.; Dubrovskii, L.A.; Sheinina, A.G.; Baibakova, N.N. (Acad of Sci of the Uzb SSR). *Geliotekhnika;* No. 1, 65-69(1977).

The aging of silazane protective coatings of radiation concentrators in a vacuum under the effect of ultraviolet radiation exceeding 5 and 40 times the UV radiation of the Sun is investigated. It is found that UV radiation reduces the transparency of a silazane coating particularly in the short-wave region of the spectrum. The temperature interval of the possible operation of silazane varnish as a protective coating for mirrors is determined. The effect of friction wear on reflection by the silazane-protected mirrors is studied.

56125 Chemical vapor deposition of thin semiconductor films for solar energy conversion. Seraphin, B.O. (Univ of Ariz, Tucson). *Thin Solid Films;* **39**: No. 1-2-3, 87-94(Dec 1976).

From Conference on metallic coating; San Francisco, CA, USA (5 Apr 1976).

The surfaces intercepting the incident radiation in solar energy converters must have a spectral profile that is properly matched to the solar emission and thermal reradiation properties, they must withstand high temperatures without harmful changes of their optoelectronic characteristics and they must operate for long enough to be economically viable. Multilayer systems deposited by chemical vapor deposition offer attractive features. The paper reviews methods of preparation and the optical performance of thin semiconductor films deposited from the vapor phase that meet all three requirements, in particular for applications at temperatures of 500$degree$C. If developed further, chemical vapor deposition will be particularly well adapted to the requirements imposed on the thin semiconductor films used in photothermal converters. 9 refs.

56126 Low cost coatings for flat plate solar collectors. Mar, H.Y.B.; Peterson, R.E.; Zimmer, P.B. (Honeywell Inc, Minneapolis, Minn). *Thin Solid Films;* **39**: No. 1-2-3, 95-103(Dec 1976).

Low cost, optically efficient, selective coatings are required for the flat plate collectors envisioned for solar heating and cooling applications. Plated coatings and paint coatings are two attractive types of coatings for this application. Black nickel (NiS-ZnS), black chrome (CrO/sub x/) and black iron (FeO/sub x/) were found to be attractive plated coatings from the standpoint of optical efficiency, durability and cost. Black nickel with $alpha$=0.95 and $epsilon$=0.07 had the best optical properties. Black chrome, which showed only minor degradation after 192 h exposure to the MIL-STD-810B humidity test, had the best durability. Black iron, with an estimated materials cost of $0.05/ft^2, had the lowest cost. Paint coatings are potentially the lowest cost selective coating. The materials cost for a selective paint coating would be about $0.05/ft^2. However, paints lack the optical efficiency of the plated coatings. The best optical performance achieved with a paint coating was $alpha$=0.90 and $epsilon$=0.30. 11 refs.

56127 Newborn in Italy: the new generation of solar panels. *Alluminio;* **45**: No. 7-8, 368-369(Jul-Aug 1976). (In Italian).

The new solar panels developed by Alsco Malugani, Alumetal and ISML were tested by Euratom and were found to provide efficiencies 20 to 50% higher than models currently employed. The new panels are assembled from finned extrusion and their higher efficiency allows the use of color paints instead of black. When selective coatings are applied on the new panels, exceptional thermal yields are obtained.

56128 Methods of calculation of profiles of focusing cones and focusing wedges. Baranov, V.K. *Geliotekhnika;* No. 6, 24-28(1976). (In Russian).

Methods permitting fast and sufficiently precise, for practical purposes, plotting of the profiles of parabolotoric focusing cones and parabolocylindrical focusing wedges are described. The values of radii/vectors necessary for the plotting of a parabola profile are given in a table. An example of calculation of the profile of a focusing cone and a focusing wedge with the parametric angle of 20$degree$ is presented.

56129 Experimental setup to measure spatial and energetic characteristics of solar concentrators. Bazarov, B.A.; Kapelyushnikov, V.M. (Phys-Tech Inst, Acad of Sci of the Turkm SSR). *Geliotekhnika;* No. 6, 29-34(1976). (In Russian).

A measuring device based on photoelectric cell is described. It enables measurement of the density of the luminant flux at any set point of the illuminated field formed by the solar concentrator with the resolving power of 1 line/mm. The same photoelectric cell permits making quantitative measurement of the density of the luminant flux by the frequency ratio method by means of an electronic digital frequency meter and actinometer. Principal results of tests of an experimental model of the measuring device are presented.

56130 Concentrating capacity of spherical facets. Zakhidov, R.A.; Khodzhaev, A.Sh. (Phys-Tech Inst im. S.V. Starodubtsev, Acad of Sci of the Uzb SSR). *Geliotekhnika;* No. 6, 35-37(1976). (In Russian).

The concentrating capacity of spherical facets is studied. Formulas are obtained for the calculation of the irradiance in the radiation field of a spherical facet. It is shown that the concentrating capacity of spherical and paraboloid facets is similar.

56131 Calculation of optical characteristics of radiant energy receivers in high temperature investigations. Zakhodov, R.A.; Il'inskii, A.I. (Acad of Sci of the Uzb SSR). *Geliotekhnika;* No. 6, 38-42(1976). (In Russian).

A theoretical investigation of the effect of the imbalance of the radiator-receiver system on the integral optical characteristics of a receiver is carried out. The values of the integral coefficient of absorption and of the integral radiation capacity of tungsten and molybdenum within a wide range of changes in the temperature of the receiver and radiator are calculated. Invalidity of Kirchhof's integral law for unbalanced selective systems is shown. 11 refs.

56132 Compound concentrators with spherical radiation sources. Paderin, L.Ya. (Cent Aerohydrodyn Inst, USSR). *Geliotekhnika;* No. 6, 43-51(1976). (In Russian).

The concentrators with spherical radiation sources that are described may be effectively used in radiation heating systems. These concentrators consist of sets of conical or spherical annuli of equal width, intersecting the generating surfaces--ellipsoids of evolution--in their initial and end sections. The source of radiation, situated at the first focus of the generating ellipsoid, consists of a spherical three-dimensional radiator with a constant intensity of radiation.

56133 Investigations of a parabolocylindrical solar energy concentrator from mollified glass sheets. Umarov, G.Ya.; Alimov, A.K.; Abduazizov, A. (Acad of Sci of the Uzb SSR). *Geliotekhnika;* No. 6, 52-53(1976). (In Russian).

The technology of manufacture and optical and energetic characteristics of a paraboloid concentrator made by the method of mollification are presented. The concentrator has the following parameters: heat capacity with the radiation of 800 W/m$sup 2$-0.9 kW, focal distance 0.5 m, area of the model 1.95 m$sup 2$, inclusion angle 108$degree$, experimental concentration 40-fold. 11 refs.

56134 Sectional facetal solar energy concentrator. Umarov, G.Ya.; Alimov, A.K.; Alavutdinov, D.N.; Abduazizov, A.; Ovechkin, N.F. (Acad of Sci of the Uzb SSR). *Geliotekhnika;* No. 6, 54-55(1976). (In Russian).

A description of a sectional collapsible seven-facet concentrator with electropolished facets, made by the method of rolling-on as applied to a mobile solar kitchen with the output of 6 l of boiling water per hr is presented. The possibility of increasing the capacity by using large-diameter facets is shown.

56135 Method of theoretical calculation of the area required for a hot box -type heat receiver. Vakhidov, A.T.; Maksudov, T.M. (Acad of Sci of the Uzb SSR). *Geliotekhnika;* No. 6, 84-87(1976). (In Russian).

A method of theoretical analysis of the relation between the area required for a tubular-type heat receiver and its thermal and geometrical parameters is presented. Its experimental corroboration is given using the example of an experimental prototype.

56136 Sharing the Sun: solar technology in the seventies. Volume 6. McConald, G.; Buzek, B.; Curtis, H. (Lewis Research Center, Cleveland). pp 162-163 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

CONF-760842—P6.

56137 Development of low-cost procedures for application of solar selective black chrome. McDonald, G.; Lauver, R.; Curtis, H. (Lewis Research Center, Cleveland). pp 164-165 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

56138 Analysis of the California solar resource. Berdahl, P.; Grether, D.; Martin, M.; Wahlig, M. (Univ. of California, Berkeley). pp 333-335 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P8.

The quality and quantity of solar data available for California are compared with the present and future requirements of various data users. An assessment is made of the value of additional data stations, and of the value of improved cooperation among the parties active in data collection and distribution.

56139 Alcoa 655 selective surface for aluminum. Powers, J.H.; Craig, A.G. Jr.; King, W. (Alcoa Technical Center, Alcoa Center, PA). pp 166-186 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

A new selective surface for aluminum has been developed. Designated the Alcoa 655 Process, advantages are good stability, low cost, and availability on full-size collectors. Coating properties, exposure data, cost, and availability are reviewed.

56140 Analytical and experimental treatment of a spray-on selective coating: application to collector design. Moore, C.S.; Ashley, T.S. III; Blum, H.A. (Southern Methodist Univ., Dallas). pp 187-204 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

This paper describes an analytical and experimental treatment of a "particulate" selective coating. Solar absorptivity and emissivity data are presented and compared with theory. The absorptivity-emissivity curve obtained by experiment suggests the existence of an optimum (α,epsilon) set which would maximize the useful energy from a collector. A method proposed by Tabor for optimizing the choice of a set of α/sub s/ and epsilon has been applied to the spray-on coating used here. The selection of the optimum set depends on "b" in the group b sigma(T⁴—T/sub c/⁴)/tau anti Q/sub s/ where "b" is complicated. When thermal capacitance effects are negligible "b" can be estimated.

56141 Solar energy utilization, solid state science, and a high efficiency amorphous-silicon absorber. Griffith, R.W. (Argonne National Lab., IL). pp 205-215 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

The electronic properties of non-crystalline, i.e., amorphous, silicon (a-Si) have interesting consequences for solar energy utilization. Of particulat interest is the enhanced optical absorption coefficient α/sub lambda/ in thin films of a-Si. Depending upon film preparation and operating conditions, such profiles α/sub lambda/ offer the following advantages relative to crystal-Si films. These are: (1) a "tunable" position of the absorption edge that allows red shifts to nearly lambda/sub g/ approximately equal to 2.1 μm; and (2) a steep profile shape that can rapidly attain α/sub lambda/ approximately 10^5 to 10^6 cm^{-1} near the center of the AM2 solar spectrum (lambda approximately equal to 0.48 μm), so that only very thin films, several tenths of a micron thick, are required for solar energy applications. In solar thermal conversion, a principal potential application is that of a high-efficiency thin-film selective absorber coating. In photovoltaic conversion, application can be made to super-shallow a-Si junctions as recently reported by several groups in the literature. Some of the underlying physical principals and relevant experimental conditions that bear on the feasibility of enhanced profiles α/sub lambda/ are surveyed and summarized.

56142 Financial incentives for the fabrication of improved absorption coatings for the flat plate collector. de Winter, F. (Atlas Corp., Santa Clara, CA); Fitzgerald, L.D. pp 216-239 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

The value of an absorption coating must be based on a determination of the total amount of useful heat which can be collected with it during a full annual cycle. This will vary with location and collection temperature. Results were obtained for the total collection capability of a single and a double glazed collector, during a full year of completely clear days, at latitudes of 32°N, 40°N, and 48°N, at a number of different temperatures covering the normal range of interest for flat plate collectors. It is shown how to use the tabulated results for the determination of coating cost effectiveness (hence allowable cost).

56143 Considerations in the development of a high performance per unit cost solar collector. Sims, W.H. (Chamberlain Manufacturing Corp., Waterloo, IA). pp 240-254 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

A flat plate solar collector with the characteristics of high unit performance at a low unit cost was developed for the National Aeronautics and Space Administration's Marshall Space Flight Center, Alabama (NASA-MSFC), under Contract NAS8-31326. The collector is capable of energy output levels commensurate with the requirements of driving an absorption refrigeration system while operating at efficiency levels in the 35 to 40 percent range. Selective absorber surfaces of black chrome over nickel and black copper over copper were analyzed. Prototype collectors containing each type absorber plating were fabricated and tested for performance in accordance with the National Bureau of Standards NBSIR 74-635, "Method of Testing for Rating Solar Collectors Based on Thermal Performance." The primary consideration during the development of the collector was to ensure the cost effectiveness of each component selected, while at the same time complying with model building codes and representative Governmental procurements for component specifications. Criteria applied to the cost effectiveness analysis of the collector included both the energy output per unit area and the collector fabrication cost per unit area. The resulting parameter is $(BTU/hr\text{-}ft^2)/(\$/ft^2)$. Comparative analyses were performed for many combinations of collector components, with major emphasis being placed on the glazing material and the absorber plate coating, both selective and non-selective. Comparison of performance per unit cost figures for combinations of variables are presented.

56144 Application of aluminum alloys for solar heating and cooling systems. Bonewitz, R.A.; King, W.; Craig, A.G. Jr. (Alcoa Technical Center, Alcoa Center, PA). pp 255-273 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.).

Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

Aluminum alloys are an excellent material of construction for solar collectors because of their low weight, good strength and formability, low cost and natural resistance to atmospheric corrosion. Consideration must be given in thermal fluid selection to avoid general or pitting corrosion and in system design to avoid galvanic, crevice or erosion corrosion. In closed systems, aluminum alloys have been employed in multimetallic heating and cooling systems charged with untreated deionized or distilled water, and where they have been shown to be non-agressive to aluminum, with some untreated natural waters. The use of suitable corrosion inhibitors is recommended for long service life. In open systems treatment is required because of concentration of the water and oxygen ingress. Ten year service experience with aluminum automobile radiators indicates that aluminum can be employed with inhibited ethylene glycol solutions with reasonable attention to the solution chemistry.

56145 Use of getters in evacuated solar collectors. Carter, W.S.; King, J.H.H. (King Labs., Inc., Syracuse, NY). pp 274-288 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P6.

The use of a getter in evacuated solar collectors is discussed. Heat conduction thru an annulus has been found for gases at low pressures and at a range of possible operating temperatures. The pressure necessary to reduce conduction heat loss to a small value of 10^{-4} torr for a 2 inch O.D. glass envelope. Barium metal is useful in maintaining a vacuum of less than 10^{4} torr. The gettering capacity of barium by gas specie is explained. The amount of barium necessary to properly maintain a vacuum for a 10 to 20 year collector life is discussed. Activation of the getter by induction heating is discussed. Typical performances of the getter regarding barium yield and begin of flash are illustrated.

56146 Weatherability of solar energy utilization materials: preliminary discussions. Gilligan, J.E.; Brzuskiewicz, J. (IIT Research Inst., Chicago). pp 289-302 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P6.

The initial efforts of a program of research and experimental testing is described in which the optical and physical performance of materials for use in solar energy utilization devices will be determined before and after exposure to outdoor weathering tests. Materials which are currently in use and others which are being considered or developed for these applications will be characterized and exposure to natural solar radiation. Outdoor testing will be accomplished in Phoenix (Ariz.), Miami (Fla.), and Chicago (Ill.). The results of these tests, primarily the effects of outdoor exposure on optical and physical properties, will be compiled in a handbook, along with cost, availability and other pertinent information.

56147 Prisms with total internal reflection as solar reflectors. Rabl, A. (Argonne National Lab., IL). pp 303-315 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P6.

In certain solar collectors, conventional mirrors can be replaced by an array of small rectangular glass prisms with total internal reflection (TIR), an optical trick well known from binoculars. The suitability of TIR prismatic reflectors for solar energy collection is investigated systematically, and the following applications are found to be promising: (1) heliostats for central receiver; (2) parabolic reflectors with point focus; (3) line focus systems (both parabolic and Fresnel reflectors) tracking around north-south axis, provided the tilt of the system is adjusted seasonally; (4) under some conditions, V- and Compound Parabolic Concentrators, in trough or cone geometry. (This is important for second stage concentrators which are to maintain high reflectivity when exposed to air at high temperatures.) Of course, reflection at the front surface of a prism will split any incident ray into separate rays which may leave the prism in two different directions. However, in all the designs considered here, all these rays will reach the absorber, and thus the effective reflectivity is indeed 100% apart from absorption losses.

56148 Reflection coefficient for a back-surface glass mirror. Kent, T.; Vant-Hull, L.L. (Pennsylvania State Univ., University Park). pp 316-324 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P6.

Many systems, the solar tower in particular, use back-silvered mirrors to reflect the solar energy to a collector. While the variation with angle of incidence of the transmission of light through glass is well documented, mirrors have not previously been considered. We have studied in detail the variation of reflectivity with angle of incidence, considering multiple reflections, polarization, spectral characteristics of the absorptivity and reflectivity, and thickness and absorptivity of the glass. We find that in most cases of interest, the reflectivity varies only a few percent for angles of incidence between +-80°, and of course, goes to unity at grazing incidence (90°).

56149 Specular reflectance properties of mirror materials. Pettit, R.B. (Sandia Labs., Albuquerque, NM). pp 331-338 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P6.

The absolute specular reflectance of flat mirrors at discrete wavelengths over the range 400 nm to 900 nm was obtained as a function of the reflected beam width from 1.0 mrad (0.057°) to 16.9 mrad (0.97°). The mirror materials were supplied by G. T. Sheldahl, 3M Company, Alcoa and Carolina Mirror Company. For some of these materials, the reflected beam profile could be described by a normal distribution. In this case, the reflectance properties are completely characterized by a solar reflectance, R/sub s/, and a standard deviation, sigma. However, for other materials, the reflected beam profile was described by the sum of two normal distributions. Data for selected materials and examples of the curve fitting procedure are presented.

56150 Heat mirror: a practical alternative to the selective absorber. Winegarner, R.M. (Optical Coating Lab., Inc., Santa Rosa, CA). pp 339-348 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P6.

Experimental data has been found to agree with calculations showing that a heat mirror coating, used in a two cover flat plate collector can be nearly as effective as a selective absorber coating. In contrast to the selective absorber coating, which is applied to the absorber plate, the heat mirror coating is applied to the inner cover glass. This feature allows one to upgrade the performance of a flat black, two cover glass collector by the replacement of an uncoated inner cover with a coated one. This retrofit will provide an absolute instantaneous efficiency increase of up to 10% and a relative daily performance increase of up to 20%.

HEAT STORAGE

REFER ALSO TO CITATION(S) 56016

56151 Thermal storage by paired ammoniated salts. Hall, C.A.; Howerton, M. (Martin Marietta Aerospace, Denver). pp 176-177 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

56152 Ammonium hydrogen sulfate decomposition for storage of energy for electrical power generation. Wentworth, W.E. (Univ. of Houston, TX); Chen, E. pp 226 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P8.

56153 New directions in heat storage for buildings. Swet, C.J. (Energy Research and Development Administration, Washington, DC). pp 1-3 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P8.

Many advanced technologies are being explored in order to overcome the limitations on solar heating and cooling of buildings imposed by presently available water and rock bed storage systems. Specific goals include higher energy density, retrofitability, higher temperatures for improved cooling system performance, yearly averaging storage for 100 percent solar operation, and incorporation into building materials for distributed storage. Some of the more promising sensible and latent heat storage technologies are discussed and tentatively evaluated from the standpoint of utility, technical feasibility, and cost.

56154 High temperature thermal energy storage. Green, R.M.; Ottesen, D.K.; Bartel, J.J.; Bramlette, T.T. (Sandia Labs., Livermore, CA). pp 5-47 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P8.

The results of a survey of current technology relating to high temperature thermal energy storage are presented. Included in this study are the generic classes of sensible heat and latent heat storage. A summary is given of thermal storage concepts which have been designed, and in some cases constructed and tested, for high temperature applications. A review of the materials and heat transfer/fluid mechanics technologies relating to thermal storage is presented. Current technology appears to be adequate to support the development of most sensible heat concepts and simple latent heat concepts while some degree of technology advancement will be required to develop more sophisticated latent heat concepts. 124 refs.

56155 Chemical methods of storing thermal energy. Offenhartz, P.O. (EIC Corp., Newton, MA). pp 48-72 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P8.

Thermal energy storage through chemical reactions is reviewed including second-law restrictions and opportunities. Second-law opportunities arise when the collection temperature exceeds the utilization temperature; in this case a thermochemically driven heat pump can be used to deliver considerably more heat than is collected. Chemical reactions can be chosen to fit the source and sink temperatures so as to amplify the input heat. A number of currently proposed methods (H_2 generation and storage, hydration-dehydration equilibria, chemical heat pipes, and ammoniacal salt pairs) are assessed with respect to efficiency, cost, chemical feasibility, and suitability for various collection and utilization temperatures.

56156 Gravel and liquid storage system for solar thermal power plants. Mitchell, R.C.; Morgan, G.R.; Coleman, G. pp 84-94 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P8.

A new thermal storage concept is described which uses a low-cost rock bed as the primary storage medium with a suitable liquid to transfer the heat in and out of storage. Key developments are described from a current program funded by the U.S. Energy Research and Development Administration. A preliminary design is described for the thermal storage subsystem in a 10 megawatt (electrical) pilot plant central receiver solar thermal power system. Also described is a 4 megawatt-hour capacity thermal storage system which has been designed and constructed, and will be tested during 1976.

56157 Demand sensitive energy storage in molten salts. Nemecek, J.J.; Simmons, D.E.; Chubb, T.A. (Naval Research Lab., Washington, DC). pp 95-106 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P8.

Heat-of-fusion energy storage and on-demand steam are obtained using heat pipe techniques to transfer heat to and from stacked salt cans and onto boiler tubes within a sealed "energy storage-boiler" tank for solar thermal power plants.

56158 Inorganic phase change materials for energy storage in solar thermal program. LeFrois, R.T.; Venkatasetty, H.V. (Honeywell Inc., Minneapolis). pp 107-122 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P8.

Honeywell Inc. is investigating the technical and economic feasibility of generating electricity from solar energy under Energy Research and Development Administration Contract E(04-3)-1109 for a Central Receiver Solar Thermal Power System Pilot Plant. The objectives of the project are: (1) to establish the technical feasibility of a solar thermal power plant of the Central Receiver type with significant commercial potential, and (2) to obtain sufficient development, production, and operating data to indicate the economics of operation for commercial power plants of similar design. Experiments for the three key subsystems, i.e., collector, receiver, and thermal storage are to be designed, constructed, and tested. The test results will confirm feasibility, and with supporting analysis, a Solar Pilot Plant design will be specified. Honeywell's conceptual design for the Thermal Energy Storage Subsystem Research Experiment and results from Phase Change Material Studies are summarized. The basic main storage concept proposed at the preliminary design baseline review is presented as the basis for the start of detail design: (1) thermal energy storage material, mixture of $NaNO_3$, NaOH phase change material. (2) thermal storage charging, transfer of latent heat of condensing steam inside circular tubes to the salt outside the tubes as latent heat of fusion. Use of convection and thermosyphon effects for bulk heat transfer. (3) thermal storage discharging, transfer of heat from the feeezing salts surrounding circular tubes to water forced-circulated through these tubes. The water, receiving heat of vaporization generates steam vapor and is supplied to a steam drum separator where saturated steam is withdrawn. The crystallized salt is removed from the outside of the tubes by mechanical means.

56159 High-temperature energy storage in native rocks. Riaz, M.; Blackshear, P.L. Jr.; Pfannkuch, H.O. (Univ. of Minnesota, Minneapolis). pp 123-137 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P8.

The successful utilization of thermal energy derived from solar collectors, from off-peak excess thermal energy of power plants, and from industrial process or waste heat systems is predicted upon the development of suitable storage systems which provide the necessary buffer and matching function between the time-varying thermal energy inputs and the output thermal and electrical loads. The technical feasibility of large-volume packed beds using native earth or rock materials for long-duration (months) storage of thermal energy at high temperatures (up to 500°C) and power levels (in the tens of MWt range) compatible with electric power generation and community heating in total energy systems context are explored. The advantages of this storage concept derive from the inherent simpicity of the overall system, from its utilization of low-cost, on-site, native materials resulting in potentially minimum environmental impact, and from the increased energy density obtainable with large temperature swings. A generic configuration of heat accumulators involving arrays of pebble-filled trenches (or holes) surrounded by undisturbed earth and fed by hot air from above or below is examined.

56160 Thermal storage in metals. Birchenall, C.E.; Telkes, M. (Univ. of Delaware, Newark). pp 138-154 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P8.

Halides and oxides with phase transformations or eutectics in the range of 200 to 800°C have been studied as heat storage materials. Several abundant and cheap metals, notably Al, Cu, Mg, Si and Zn as binary or more complex alloys, have eutectic transformations that store comparable or larger amounts of heat. Their high molar densities yield small storage volumes, and high thermal conductivities simplify heat transfer. Containment should be easier than for oxides and halides. Thermodynamic theory shows that alloys selected for heat storage should have highly disordered eutectic liquids that freeze to well-ordered, strongly bonded solid phases. Heat storage in several promising binary and ternary alloys for which data are available has been estimated at three levels of approximation to illustrate the approach that is being used to identify suitable systems and the uncertainties that need to be resolved by additional experiments.

56161 Thermal energy storage using large hollow steel ingots. Turner, R.H. (Jet Propulsion Lab., Pasadena, CA). pp 155-162 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P8.

High temperature thermal energy storage (to 500°C = 930°F) using hollow steel ingots is investigated. Preliminary studies indicate that the system should be reliable, characterized by low operation and maintenance costs and associated with low development risk. The estimated installed system energy unit storage cost is $13.50/kWh-t.

56162 Thermal energy storage by the sulfuric acid—water system. Huxtable, D.D.; Poole, D.R. (Rocket Research Corp., Redmond, WA). pp 178-191 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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The sulfuric acid-water storage system utilizes solar thermal energy to evaporate water from a sulfuric acid-water solution. The sulfuric acid and water are stored separately until heat is required. Upon recombination of the concentrated acid and water, heat is released which can be used for building heating and cooling, water pumping, or other uses. Results of an investigation aimed at defining potential problem areas and providing practical solutions are presented. Potential applications of the system are discussed, and preliminary design and cost information on a seasonal storage application is presented.

56163 Storage of solar energy by inorganic oxide/hydroxides. Bauerle, G.; Chung, D.; Ervin, G.; Guon, J.; Springer, T. (Rockwell International, Canoga Park, CA). pp 192-218 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P8.

A novel thermal-energy storage concept involving the use of inorganic oxides/hydroxides such as $MgO/Mg(OH)_2$ and $CaO/Ca(OH)_2$ is under investigation. Solar energy at high temperatures (approximately 350 to 550°C) is used to drive off, in the form of steam, the chemically bound water from the hydroxide. At a later time, when the sun's energy is not available, water or steam can be injected into the resulting oxide material, thus yielding heat energy from the exothermic reaction of water with the oxide. The physical and chemical properties of the $MgO/Mg(OH)_2$ systems, particularly the reaction rates, thermal conductivity, vapor pressure, and particle characteristics, have been investigated in detail. A reference design of an $MgO/Mg(OH)_2$ storage system for heating and cooling of buildings has been prepared and a variety of other applications of these systems have been studied.

56164 Reversible oxidation of metal oxides for thermal energy storage. Simmons, J.A. (Science Applications, Inc., McLean, VA). pp 219-225 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

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See CONF-760842—P8.

Decomposition of metal oxides, especially peroxides and superoxides, are proposed as reversible reactions to store thermal energy. Certain oxides have potentially high energy density and could use air for the source of oxygen. Feasibility is yet to be demonstrated experimentally.

56165 Thermal energy storage with saturated aqueous solutions. Kauffman, K.W.; Lorsch, H.G. (Franklin Inst. Research Labs., Philadelphia). pp 227-237 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

A method of thermal energy storage at temperatures of 0°C to 120°C is being developed for application to solar space heating, water heating and air conditioning. The method uses saturated aqueous solutions of salts which dissolve endothermically and have large coefficients of solubility with temperature. Latent heat of crystallization is continuously released on cooling and absorbed on heating, resulting in specific heat capacities up to 480 percent of the specific heat of water. Over a 10°C range of temperature, storage densities can be achieved which are in the same range as those of latent heat of fusion materials. Since the solutions are pumpable, systems employing them do not require the expensive container/heat exchangers characteristic of latent heat devices using phase change materials. Total costs for a 10^8 joule storage device are $\frac{1}{4}$ to $\frac{1}{2}$ the cost of devices using sodium thiosulfate pentahydrate or 50 percent water-ethylene glycol.

56166 Experimental study of the subsurface transport of water and heat as related to the storage of solar energy. Molz, F.J. (Water Resources Research Inst., Auburn, AL); Warman, J.C.; Jones, T.E.; Cook, G.E. pp 238-244 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

Solar heating systems have been proposed wherein confined ground water aquifers are utilized as temporary storage reservoirs for solar-heated water. Thus, there is a practical motivation for obtaining a better understanding of subsurface water and heat transport. The Water Resources Research Institute of Auburn University is performing an aquifer injection and recovery experiment involving heated water. Hot water will be pumped into a confined aquifer, stored within the aquifer for a period of time and pumped out of the aquifer. During this time, hydraulic head and water temperatures will be recorded in an array of 14 observation wells. The data should serve as a base for testing the predictive abilities of any numerical models describing simultaneous transport of water and heat in the phreatic zone. In addition, the experiments will provide direct experience with the various technical problems related to the subsurface storage, recovery, and use of water heated by solar energy.

56167 Thermocrete heat storage materials: applications and performance specifications. Chahroudi, D.; Wellesley-Miller, S. (Suntek Research Associates, Corte Madera, CA). pp 245-259 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

Thermocrete energy storage materials are made by combining phase change materials with open cell cements to produce low cost energy storage materials with structural and thermostatic properties. Thermocrete blocks, tiles and panels can be manufactured and installed as either isolated modular units coupled to conventional HVAC or solar collector systems or used to provide distributed heat storage throughout the building fabric when integrated with standard structural components or interior and exterior building finishes. Potential application areas for Thermocrete materials are discussed in general terms. Thermocrete blocks are specifically analyzed in more detail concerning modes of operation, performance specifications and energy savings in various applications.

56168 Immiscible fluid: heat of fusion energy storage system. Edie, D.D.; Melsheimer, S.S. (Clemson Univ., SC). pp 262-272 of In Sharing the Sun: solar technology in the seventies. Volume 8. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P8.

Preliminary studies of a novel heat of fusion energy storage system have been conducted. This system uses direct contact heat transfer between an aqueous crystallizing solution and an immiscible heat transfer fluid. The phase change solution is permanently contained in an insulated storage tank. A heat transfer fluid (which is immiscible in the phase change solution) is circulated through the solution and transfers heat either to or from the solution. By eliminating permanent heat exchange surfaces, this immiscible fluid system avoids the phase stratification problem which has negated the potential storage efficiency of many previous heat of fusion systems. The target energy density for this heat storage system design is 3.5 x 10^8 joules per cubic meter. The estimated cost for stoage of 1.0 x 10^9 joules is $1,100.

GEOTHERMAL ENERGY

56169 (LBL—6305) **Standards for multilateral and world wide exchange of geothermal data.** Herr, J.J.; Phillips, S.L.; Schwartz, S.R.; Trippe, T.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1976. Contract W-7405-ENG-48. 12p. (CONF-7609142—1). Dep. NTIS, PC A02/MF A01.

From International geological correlation program) standards for computer applications in resource studies; Loen, Norway (27 Sep 1976).

Standards for the exchange of machine-readable data are discussed at five levels covering (1) physical characteristics of the medium used in the exchange, (2) overall structure of the data file, (3) format of individual records, (4) types of information contained in a record, (5) authority files for information definition. The standards are used by the National Geothermal Information Resource for compilations of geothermal energy data.

RESOURCE STATUS AND ASSESSMENT

REFER ALSO TO CITATION(S) 56986

56170 **Free' and renewable energy sources.** Wise, C. E. *Mach. Des.;* **49**: No. 12, 22-28(26 May 1977).

Geothermal resources in the US include dry steam, hot water, geopressurized water, hot dry rock, crustal gradients, and magma. The most recent US Geological Survey estimate shows that the energy content of magma located within 10 km of the surface is equivalent to 700 times the US energy consumption in 1974. Research is being conducted on the development of heat exchange systems for direct energy extraction from magma. Much of this research is under the auspices of USERDA. Sandia Laboratories is studying locations for magma experiments, methods of drilling, heat exchangers for magmatic environments, and heat transfer properties. Other applications of geothermal energy include domestic heating and electrical power generation from shallow and surficial steam and hot water sources. USERDA predictions and budgets for various energy sources are graphed. Renewable energy sources other than geothermal are reviewed. These include solar, wind, ocean thermal, and biomass.

56171 **Utilization of geothermal energy in dry rock masses.** Knapp, V.; Coffou, E. *Brennst.-Waerme-Kraft;* **29**: No. 5, 195-198(May 1977). (In German).

Several models of hot dry rock systems are discussed. The production limits over a 50 year period are calculated for a model based on a spherical hollow space filled with crushed rock and having a radius of 1 km. The other models examined vary in the shape of the crushed rock and the heat transfer properties of the system. Critical analysis of the results shows that hot dry rock systems cannot be expected to produce electricity at a level of 100 MW for at least another 30 years, based on present rock fracturing technology.

56172 **More about geothermal steam or the hottest energy prospect ever.** Birsic, R.J. Fullerton, CA; R. J. Birsic (1976). 176p.

Geothermal development around the world is described. Countries covered are: Mexico, Iceland, Japan, Central America, USA, The Philippines, and others. Other subjects discussed are: the only privately owned geyser in the world, the Burbank story, and the financial aspects of geothermal development. (MHR)

56173 **Geothermal heat.** Gouguel, J.; Olivet, J. *Chauffage - Vent. - Cond.;* **51**: No. 2, 5-19(Mar 1975). (In French).

Subjects included are: principles of exploitation; difficultues of boring; reinjection of used water to avoid source exhaustion; water corrosivity; optimum heating arrangements; and capital investment.

NON-USA

56174 **Utilization of geothermal energy for heating of Swiss cities.** Jaffe, F.; Cuenod, M.; Vercellini, R. (Univ., Geneva). *Bull. Tech. Suisse Romande;* **101**: No. 22, 351-359(23 Oct 1975). (In French).

A study of the possibilities offered by geothermal sources in Switzerland for heating of residential houses is made. The problems to be solved prior to actual drilling works are discussed. A geothermal map of Switzerland is also given.

56175 **Geothermal resources in this country.** Hotchkiss, R.C. *Electr. Times;* No. 4331, 2(16 May 1975).

The possibility of exploiting geothermal resources in UK is being investigated at Marchwood Engineering Labs. Areas in Cheshire, Cornwall and W. Durham have rock temperature gradients of 20 to 40°C/kM.

56176 **Geothermal resources.** Suyama, J. (Geol. Survey of Japan). *Sekiyu Gakkaishi;* **18**: No. 6, 17-21(1975). (In Japanese).

Japan possesses about 200 volcanoes formed during the Quaternary. These volcanoes gave rise to 15,827 hot springs which demonstrate an average temperature of 57°C. The springs radiate about 8 x 10^{10} kcal/day to the atmosphere. In 1975 the operational geothermal power plants were Matsukawa (22 MW), Otake (13 MW), and Onuma (10 MW). The plants being developed at that time (including Onikobe, Yakinoue, Hatchobara, Nigorikawa, Koyasu and Akinomiya) were projected to increase the total geothermal generation capacity to 340 MW. Although this is not as extensive a capability as possessed by many other countries, it is expected that further development of Japanese geothermal resources will be extensive. There are more than 91 hot spring fields with temperatures above 90°C. It is believed that only 10 of these fields can produce up to 1000 MW. It is also felt that about 10 GW can easily be extracted from reservoirs at depths of less than 1.5 km. Thirty of these fields were chosen for intensive investigation and evaluation.

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

USA

56177 (PB—265038) **Terrestrial heat flow along the Rio Grande rift, New Mexico and southern Colorado.** Reiter, M.; Edwards, C.L.; Hartman, H.; Weidman, C. (New Mexico Inst. of Mining and Technology, Socorro (USA)). 1975. Contract DI-14-06-500-1875. 10p. NTIS PC A02/MF A01.

From heat-flow data obtained in New Mexico and southern Colorado, one finds: (1) a major geothermal anomaly with heat-flow values greater than 2.5 HFU (heat-flow unit, microcal/(sq cm) sec) coincident with the western part of the Rio Grande rift; (2) a complex heat-flow pattern in the eastern Colorado Plateau with values of 1.5 HFU and less, apparently associated with major structural basins, and values of 2.0 HFU and greater, apparently associated with some intrusions and perhaps major uplifts; and (3) a regional increase in heat-flow values from 1.5 to 2.0 HFU to values greater than 2.5 HFU in southwestern New Mexico, which may be coincident with the north-trending geothermal transition zone between the Colorado Plateau and the Basin and Range provinces.

NON-USA

56178 **Development of geothermal models.** Liubimova, E. A. *Izv. Akad. Nauk SSSR, Fiz. Zemli;* **77**: No. 1, 40-55(Jan 1977). (In Russian).

Geothermal models related to the study of the evolution of the earth and to the interpretation of surficial heat fluxes are reviewed. The models are based on A.N. Tikhonov's theory of heat conduction. Heat flow was determined at over 5000 sites on the continent and ocean bottom in Eastern Europe and the Soviet Union. The mean thermal flux at the earth surface was found to be 1.48 plus or minus 0.76 HFU; 1.40 plus or minus 0.50 HFU on the continent and 1.51 plus or minus 0.50 HFU for the oceans. The global heat loss of the earth amounts to 7.55 Tcal/sec. Most anomalies in heat flow extend over both continental and oceanic regions; the distribution is independent of the crustal composition, which indicates that the heat originates at depth. The similarity of continental and oceanic heat flow is indicative of the contribution of the asthenosphere to the flux. Heat flow distribution is most inhomogeneous in faults, near the oceanic ridges and along the transition of continental to oceanic crust. A discussion is presented of two-dimensional geothermal models and their quantitative evaluation. Particular attention is paid to significance evaluations which permit the development of guidelines for determination of the relationship of geothermal, topographic, seismic and magnetic quantities.

56179 Observation of temperature and water level in Hakone volcano, 1973. Hirota, S.; Odaka, S. (Hot Spring Research Inst. of Kanagawa Prefecture, Hakone, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **5**: No. 1, 15-22(1974). (In Japanese).

The temperature of thermal waters and water levels of several wells in Hakone was observed continuously during 1973. The temperature anomaly of thermal waters encountered in the eastern flank of Kamiyama where a central cone had been maintained more than 6 years is described. A temperature logging of a deep well in the area of the temperature anomaly indicated that the temperature of the major aquifer of thermal water had increased by 4°C since the 1972 logging, suggesting the continuation of the temperature anomaly. Orifice temperature of Miyanoshita Hot Spring at the eastern end of the high temperature subsurface stream (zone III) also increased by 2°C in a year.

56180 Observation of a newly appeared active fumarole at Owakudani, Hakone volcano. Hirota, S.; Hirano, T.; Oki, Y. (Hot Spring Research Inst. of Kanagawa Prefecture, Hakone, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **5**: No. 1, 23-30(1974). (In Japanese).

An active fumarole, gushing 3 to 4 meters high out of clayish muds, appeared at the Owakudani solfataric field, northern foot of Kamiyama, Hakone volcano. At the beginning of appearance, Feb., 1973, the diameter of fumarole was about 3 meters, and expanded to about 9 meters on Dec., 1973. Temperature of thermal water of the new fumarole has been observed since Feb. 1973. The observed temperature in 1973 ranged from 94 to 96°C. The highest one was 96.8°C on Sept. 8th, 1973. The variation of fumarole temperature in this area cannot be clearly correlated with variation of precipitation. The major chemical components of thermal water collected from the new fumarole are Fe^{2+}, SO_4^{2-}, and SiO_2, resembling to those of the surface waters of this solfataric field.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

GEOPHYSICAL TECHNIQUES AND SURVEYS

56181 Method for identifying anomalous terrestrial heat flows. Kerr Del Grande, N. (to Energy Research and Development Administration). US Patent 4,005,289. 25 Jan 1977. Filed date 5 Jan 1976. 8p.

PAT-APPL-646,444.

A method for locating and mapping the magnitude and extent of terrestrial heat-flow anomalies from 5 to 50 times average with a tenfold improved sensitivity over orthodox applications of aerial temperature-sensing surveys as used for geothermal reconnaissance. The method remotely senses surface temperature anomalies such as occur from geothermal resources or oxidizing ore bodies by: measuring the spectral, spatial, statistical, thermal, and temporal features characterizing infrared radiation emitted by natural terrestrial surfaces; deriving from these measurements the true surface temperature with uncertainties as small as 0.05 to 0.5 K; removing effects related to natural temperature variations of topographic, hydrologic, or meteoric origin, the surface composition, detector noise, and atmospheric conditions; factoring out the ambient normal-surface temperature for non-thermally enhanced areas surveyed under otherwise identical environmental conditions; distinguishing significant residual temperature enhancements characteristic of anomalous heat flows and mapping the extent and magnitude of anomalous heat flows where they occur. 7 claims, 6 figures.

56182 (NP—22280) Subsurface temperature data in Jemez Mountains, New Mexico. Circular 151. Reiter, M.; Weidman, C.; Edwards, C.L.; Hartman, H. (New Mexico Bureau of Mines and Mineral Resources, Socorro (USA)). 1976. 16p. Mexico Bureau of Mines and Mineral Resources, Socorro, NM.

Temperature data taken in 13 drill tests around the Valles Caldera are presented. Seven of these tests were shallow auger holes (less than approximately 30m), 4 were rotary holes of intermediate depth (140 m to 170 m), and 2 were relatively deep tests (350 m and 730 m). Heat-flow measurements were obtained in the 4 intermediate drill tests whereas only geothermal gradients were measured in the remaining tests. Potential ground-water movement, lack of good thermal conductivity control, and the shallow depth of many of the drill tests makes the heat-flow pattern in the area uncertain. Two trends appear likely: higher heat flows are to the western side of the Valles Caldera (as opposed to the eastern side) and heat flows increase rapidly in approaching the margin of the Valles Caldera from the west. Both observations suggest a relatively shallow heat source located beneath the western part of the Valles Caldera.

56183 Heat discharge measurement and geophysical prospecting at Nigorikawa basin, northern part of Komagatake. Urakami, K.; Nishida, Y. *Chishitsu Chosasho Geppo;* **28**: No. 1, 1-20(Jan 1977). (In Japanese).

The Nigorikawa basin is located at the northern part of Komagatake active volcano in the southwestern Hokkaido. It is a small caldera formed in the Pleistocene era. There are a large number of hot springs and a few fumaroles in the northern half of the caldera. Some geophysical surveys, such as temperature surveys, seismic reflection surveys, and magnetic measurements by proton magnetometer were carried out in the basin. Results of temperature measurements and geochemical studies suggest that hot water of high NaCl-content is ascending from the depth through the fissure-system along the northern caldera wall and the very porous sediments at the central area, but at the western area the thick, impermeable surface layer prevents its upward flow. The total heat discharge from Nigorikawa hot springs area was estimated as 21.4 x 10^7 cal/min. At the central part of the caldera, a total magnetic force anomaly up to 1000 γ was observed. This coincides with the positive residual gravity anomaly discovered in the earlier survey. These anomalies are interpreted to be derived from the intrusive igneous rock body of circular cylinder of radius 225 meters having an upper surface at depth 150 meters.

56184 Total heat discharge from northern Azuma geothermal area. Sekioka, M. *Chishitsu Chosasho Geppo;* **28**: No. 1, 21-31(Jan 1977). (In Japanese).

Visual surface manifestation of geothermal activity in northern Azuma geothermal area is centralized mainly to the cliffs along the River Maekawa at Ubayu spa in the southeastern part of this area. In Ubayu spa area, geothermal heat is transferred (1) by hot springs flowing from the east-side cliff and from the bottom of the River Maekawa and (2) in vapor and by conduction through the cliffs. In October 1973, a measurement was carried out to determine the total heat discharge from this geothermal area, forming a part of the Geothermal Basic Survey. Heat transferred convectively from self-flowing springs was evaluated at 1.15 x 10^8 cal/sec, while heat transferred through high-gradient near-surface ground was estimated to be 6.01 x 10^4 cal/sec from the surface temperature field based on the heat budget method. Moreover, convective heat transferred from 'Eight spas of Azuma' other than Ubayu spa was found to be 2.60 x 10^6 cal/sec. Thus total heat discharge was determined 3.81 x 10^6 cal/sec from northern Azuma geothermal area.

56185 Ground temperature surveys and thermal discharge measurements at Ibusuki and its surrounding geothermal areas. Yuhara, K.; Ushijima, K. *Chishitsu Chosasho Geppo;* **28**: No. 1, 33-56(Jan 1977). (In Japanese).

Underground temperatures in 1 m depth were measured at Ibusuki, Unagi, Nagasakibana and Fuseme geothermal areas, and several shallow bore holes up to 10 m were also drilled in these areas to measure the ground temperatures and the goethermal gradients. The temperature surveys were made to get information on the underground thermal structures. In the same geothermal areas, thermal discharges from hot springs, fumaroles, steam wells, steaming grounds and heat conduction through ground surface were measured. Total heat discharge from four geothermal areas amounts to 39 x 10^8 cal/sec, in which 95.4 percent is thermal discharge from hot springs, 1.2 percent steam from wells, 2.7 percent from steaming grounds, and 0.7 percent by thermal conduction through soils.

56186 Reproducibility of the distribution of the underground temperature at one meter depth and one verified example of the availability of underground temperature survey. Takeuchi, A.; Shima, M. *Butsuri Tanko;* **29**: No. 6, 11-18(Dec 1976). (In Japanese).

Temperature surveys were carried out at 1 m depth and studies were made of ground water. The temperature distribution at 1 m was not found to be accidental, as it was reproduced in several trials. On the basis of the data derived, two boreholes were sunk in high and low temperature areas and the ground water withdrawn was studied. Fairly viscous water was found to flow in the low temperature zones. The water present in high temperature areas was stagnant. The flow rate in the low temperature zones was measured at 1.6 mm/sec. In the high temperature zones it was 0.02 mm/sec.

56187 Heat flow map of Poland on the background of the European geothermal field and some aspects of its interpretation. Majorowicz, J. (Geol. Inst., Geophys., Warsaw). *Acta Geophys. Pol.;* **24**: No. 2, 147-156(1976). (In Polish).

A heat flow map of Poland was prepared. Analysis of the map and related geological data suggests that the difference between high heat flow values on the western Paleozoic platform and low heat flow on the northeastern Precambrian platform may be related to the difference in mantle heat flow contribution in those provinces. It is shown that the statistical linear relationship between heat flow and heat production in tectonically stable (pre-Devonian) areas is a characteristic curve for data from different continental heat flow provinces. Temperature/depth profiles for western and northeastern Poland are provided and 27 references are given.

56188 Seismometrical observation in Hakone volcano, 1973. Hiraga, S.; Ito. H.; Hakamata, K.; Kohzuma, N.; Kobayashi, T. (Hot Spring Research Inst. of Kanagawa Prefecture, Hakone, Japan).

Bull. Hot Spring Res. Inst., Kanagawa Prefect.; 5: No. 1, 1-14(1974). (In Japanese).

Seismic activity of Hakone volcano was calm in the period from January to December of 1973; only 140 microearthquakes with (s-p) time interval less than 5 sec were recorded. Most of the well-located microearthquakes occurred at depths of 0 km to 3 km, directly beneath the geothermal area of Owakudani and Sounzan as in the previous years. A microseismic activity was recognized in accord with the earthquake swarm of Oshima volcano, 70 km southeast of Hakone volcano, during the period from October 11 to November 15.

GEOCHEMICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 56180, 56209

56189 Chemical and isotopic investigations of groundwater in potential geothermal areas in Hawaii. McMurtry, G.M.; Fan, P.; Coplen, T.B. (Univ of Hawaii, Honolulu). *Am. J. Sci.;* 277: No. 4, 438-458(Apr 1977).

The chemical and isotopic compositions of Hawaiian groundwater were studied to locate and evaluate potential geothermal areas. Analyses were made of 43 samples from 27 wells, two coastal springs, local precipitation, and steam. Three methods of chemical geothermometry were applied: (1) silica, (2) Na-K-Ca, and (3) stable isotope or deuterium-oxygen-18. Based on the silica and stable isotope methods, the most promising geothermal areas are the summit of Kilauea Volcano and the area near geothermal test hole 3 in the Puna district (east rift zone of Kilauea Volcano) 43 refs.

56190 Antimony content in the hot spring waters in Gunma Prefecture. Sakai, Y.; Hara, Y.; Takishima, T. (Gunma Inst. of Public Health, Japan). *Onsen Kagaku;* 27: No. 4, 127-133(Mar 1977). (In Japanese).

Antimony content in the hot spring waters in Gunma Prefecture was determined by the colorimetric method with Rhodamine B. Total number of hot springs thus examined were 60. The results obtained were as follows: (1) The hot springs in which antimony was detected were Yunokoya, Takaragawa, Sarugakyo, Shima, Kusatsu, Manza, Kawarayu and Yakushi. Among them the highest concentration of antimony, 0.050 mg/l Sb, was detected in the Shima hot spring water. (2) In the thermal spring water, there is a considerable high positive correlation between the content of antimony and that of chloride and arsenic. (3) The geology in which antimony was detected in the hot spring waters was the neutral or the acidic igneous rocks. (4) In general, antimony was detected in the hot spring waters from the northwestern to the northern part of Gunma Prefecture.

56191 Calcium chloride springs of sea water origin in Toi Hot Spring. Kanroji, Y.; Mashiko, Y. (Hot Spring Research Center's Inst., Japan). *Onsen Kagaku;* 27: No. 4, 134-142(Mar 1977). (In Japanese).

Toi hot springs are situated on the West coast of Izu peninsula, facing Suruga bay. At present, there are five wells, the temperature of their water ranges from 53.6 to 61.0°C. The total amount of flow is 3600 m^3/day. The chemical characteristics of the thermal springs in Toi area can be classified into two types; one type is calcium sulfate springs of low salinity, and other type is calcium chloride springs of high salinity. Thermal waters were originally calcium sulfate type in the area and calcium chloride springs are formed by the intrusion of sea water into thermal water of calcium sulfate type. The intrusion of sea water may be caused by the overlifting of underground water and thermal water issuing tunnels in Toi-mine near the spring wells. Analysis of the thermal water of calcium chloride type shows chemical composition different from a simple proportional mixing of sea water and the thermal water of calcium sulfate type. In the process of the intrusion, the composition of sea water changes to $CaCl_2$ type by the following reactions between sea water and minerals in the strata. (1) Decrease of potassium, sodium, and magnesium ions, and increase of calcium ion. Ion exchange effects by minerals play an important role in the reaction. (2) Deposit of calcium sulfate (anhydrite): Calcium sulfate is formed by the reaction between sulfate ion of sea water and calcium ion separated from the minerals. The reaction is deduced from the analysis of ion product, $[Ca^{2+}][SO_4^{2-}]$ in sea and thermal water.

56192 Boric acid content of hot springs and river waters at Owakudani Valley, Volcano Hakone. Aikawa, K. (Toho Univ., Japan). *Onsen Kagaku;* 27: No. 4, 143-153(Mar 1977). (In Japanese).

The titration method was examined, using mannitol for boric acid in mineral waters and found that it is necessary to use sodium hydroxide instead of ammonium hydroxide in neutralization to precipitate iron and aluminium in acid samples. The highest temperature and the highest contents of chemical components in hot springs and river waters at Owakudani Valley were found to be as follows: Water temperature 94°C, pH 6.7 (the lowest value 2.1) Cl 900 mg/l, SO_4 4118mg/l, Fe 320 MG/l, Al 460 mg/l, Ca 367 mg/l, Mg 477 mg/l, SiO_2 360 mg/l and HBO_2 15 mg/l. The sulfate, aluminium and iron contents of river water changed parallel with each other during its descent along the Owakudani Valley. It was found that a linear relationship exists between the chloride and boric acid contents.

56193 Subsuperficial changes in chemical composition of the thermomineral waters of Vichy basin. Geothermal implications. Michard, G.; Stettler, A.; Fouillac, C.; Ouzounian, G.; Mandeville, D. (Paris Univ.). *Geochem. J. (Nagoya);* 10: No. 3, 155-161(Oct 1976).

The chemical analyses of the mineral waters issuing in the basin of Vichy St. Yorre provide the means to decipher different subsuperficial modifications superposed on the fluid originating at great depths: increasing amounts of dissolved Ca, Sr, Mg and sometimes K, by gradual attack of shallow host rocks; precipitation of silica and associated aluminium; and mixing with fresh surface waters. The comprehensive study of these alterations sheds light on the initial composition of deep water. From the silica content, the Na/K ratio and the calcide saturation, a temperature of 135°C is inferred for this water.

ECONOMIC AND FINANCIAL ASPECTS

56194 (BNWL—2192) **Analysis of electricity production costs from the geopressured geothermal resource.** Bloomster, C.H.; Knutsen, C.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Feb 1977. Contract EY-76-C-06-1830. 75p. Dep. NTIS, PC A04/MF A01.

The economics of the geopressured geothermal resource along the northern coast of the Gulf of Mexico is assessed. Geopressured waters are nearly under twice the normal hydrostatic pressure and believed to be saturated with methane. The costs of generating electricity from this resource are estimated based on the description and conceptual development plans provided by the United States Geological Survey (USGS). Methane content and selling prices are the most important factors affecting the commercial potential of geopressured resources—so it is important that electrical generation be viewed as a by-product of methane production. On the same incremental cost basis, the cost of electricity generated from the geohydraulic energy is potentially competitive with conventional energy sources. This would require development of a small commercial high pressure, hydraulic turbine to extract geohydraulic energy at the wellhead in plants of about 3 MW capacity. Price/quantity relationships are developed for electricity generation from geopressured resources for each of three development plans proposed by USGS. Studies, based on field constructed plants, indicated an optimum power plant size in the range of 20 to 60 MWe, depending on water temperature. However, if standardized thermal conversion power plants could be factory produced in the 6 MWe range competitively with larger field constructed plants, then the optimum plant size might be reduced to single wellhead units.Wellhead units would completely eliminate fluid transmission costs, but would probably incur higher costs for heat rejection, power plant operation, and electrical transmission. The upper cost target for competitive wellhead plants would be on the order of $800/kW in 1975 dollars.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

56195 (NP—21722) **Effects of geothermal energy utilization on stream biota and water quality at The Geysers, California. Final report.** LeGore, R.S. (Parametrix, Inc., Seattle, Wash. (USA)). 1975. 312p. Inc., Seattle, WA.

The discussion is presented under the following section headings: biological studies, including fish, insects, and microbiology; stream hydrology; stream water quality, including methods and results; the contribution of tributaries to Big Sulphur Creek, including methods, results, and tributary characterization; standing water at wellheads; steam condensate quality; accidental discharges; trout spawning bed quality; major conclusions; list of references; and appendices. It is concluded that present operational practices at Geysers geothermal field do not harm the biological resources in adjacent streams. The only effects of geothermal development observed during the study were related to operational accidents. (JGB)

56196 Radon emanation in geothermal steam. Kruger, P.; Warren, G.J. (Stanford Univ., CA). *Trans. Am. Nucl. Soc.;* 26: 125(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56197 Predicting the effect of geothermal emissions on the temperature and relative humidity in the Imperial Valley of California.

Kelley, R.E. (Univ of Calif, Lawrence Livermore Lab). *Geotherm. Energy Mag.;* 5: No. 1, 18-22(Jan 1977).

Estimated values are given for temperature and relative humidity changes resulting from water-dominated geothermal energy sources in the Imperial Valley of Southern California. Statistical Gaussian equations for atmospheric dispersion are used to obtain incremental increases in relative humidity and temperature for various locations within about 100 km of the geothermal sites. The results show measurable changes in both parameters at some population centers with nightime variations exceeding daytime changes. 6 refs.

GEOTHERMAL POWER PLANTS

56198 Geothermal energy as a source of electric power. Thermodynamic and economic design criteria. Milora, S.L.; Tester, J.W. Cambridge, MA; Massachusetts Institute of Technology (1976). 194p.

The resource base and its potential environmental impact are assessed. Power cycle and resource utilization efficiencies are described with empirical equations and correlations. Detailed cycle calculations performed with seven representative working fluids that were selected to illustrate a range of molecular properties are presented. Turbine and pump design criteria are discussed. An economic model is developed based on separate cost equations or correlations for the major power plant components and geothermal wells. It is concluded that geothermal power generating costs can compete with the present escalated fossil-fuel and nuclear generating costs, and that geothermal resources are large enough to have an impact on our energy economy. (MHR)

DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 56194

POWER PLANT SYSTEMS AND COMPONENTS

56199 Method of removing dissolved non-condensibles from geothermal brines. Matthews, W.T. (to Dow Chemical Co.). US Patent 4,026,111. 31 May 1977. Filed date 3 Feb 1976. 6p.

Heat energy is more efficiently recovered from geothermal brines by preflashing the brine to remove dissolved, non-condensible gases before flashing the brine to produce motive steam. Power requirements for removal of non-condensibles from turbine exhausts (in order to maintain adequately low exhaust pressures) are obviated. The heat content of the pre-flashed vapors may be largely utilized for superheating and reheating the motive steam. 4 claims, 1 figure.

56200 Boiler of tubular nature. Sato, S. Japanese Patent 1952-55,034. 6 May 1977. Filed date 31 Oct 1975. 2p. (In Japanese).

In order to develop power generation from magmatic heat, an invention was developed which consists of a tubular boiler which is inserted into the magma. Water is passed through the device and is converted to high temperature, high pressure steam which may be used to drive a turbine. The boiler consists of a flexible thermal collector, a blind pipe, a closed-type steam generator, and an accumulator/conduit. The tubular tip of the heat exchanger is constructed from both high melting point (+2000°C) and low melting point (1000°C) alloys which are combined in an alternating arrangement similar to the cloth and frame of an umbrella. This provides for the maintenance of a flexible structure when the exchanger is inserted into the magma.

GEOTHERMAL ENGINEERING

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

56201 (LBL—6324) Nitinol self-descaling surface for geothermal scale control. Weres, O. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1977. Contract W-7405-ENG-48. 9p. Dep. NTIS, PC A02/MF A01.

The shape memory effect (SME) in Nitinol is discussed. The second memory phenomenon in Nitinol wires which have been working in a heat engine for some time is described. The ways in which the SME may be applied to scale control are listed. The demonstration of the concept with actual geothermal brine is described. The application of SME in the kind of scaling encountered at Cerro Prieto, Mexico is proposed. (MHR)

56202 Geothermal power plants and their material trends. Yoshida, H. (Tokyo Shibaura Elec. Co., Japan). *Tetsu To Hagane;* 63: No. 7, 142-154(1977). (In Japanese).

About 2 GW in new geothermal power stations are planned for construction in the 1977-1985 time period in Japan. It is hoped to attain an increase of 80% per year in geothermal developments. Important to widespread exploitation of Japan's resources is the development of corrosion resistant materials. At Matsukawa geothermal field, in-situ testing has shown that copper is most susceptible to corrosion while stainless steels are intermediate and titanium is most resistant. X-ray analysis of corrosion products detected the presence of FeS, FeS_2 and CuS, indicating that H_2S is the primary reagent. Corrosion was much lower in components exposed to condensed products than in those where vapor was present. Quantitative corrosion testing has also been performed at Mexicali, Mexico and the Geysers, USA. Turbines designed on the basis of this testing have performed well, although the stellite alloy used is showing signs of corrosion after two years. The turbine rotors were built from Cr-Mo-1/4V steel. This steel cannot be used in generators larger than 50 MW capacity due to a tendency to cracking in large components. As a result of experience with in-situ testing at the Takinoue, Koyasu, Takeyu and Nigorigawa fields, materials have been selected for use in binary phase systems. SUS 304 steel and titanium tubing will be used in the heat exchangers.

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

56203 Geothermal energy control system and method. Matthews, H.B. (to Sperry Rand Corp.). US Patent 4,025,240. 24 May 1977. Filed date 10 Nov 1975. 16p.

A geothermal energy transfer and utilization system makes use of thermal energy stored in hot solute-bearing well water to generate superheated steam from an injected flow of clean water; the superheated steam is then used for operating a turbine-driven pump at the well bottom for pumping the hot solute-bearing water at high pressure and in liquid state to the earth's surface, where it is used by transfer of its heat to a closed-loop boiler-turbine-alternator combination for the generation of electrical or other power. Residual concentrated solute-bearing water is pumped back into the earth. The clean cooled water is regenerated at the surface-located system and is returned to the deep well pumping system also for lubrication of a novel bearing arrangement supporting the turbine-driven pump system. The bearing system employs liquid lubricated thrust and radial bearings with all bearing surfaces bathed in clean water serving as a lubricant and maintained under pressure to prevent entry into the bearings of contaminated geothermal fluid, an auxiliary thrust ball bearing arrangement comes into operation when starting or stopping the pumping system.

SAFETY AND CONTROL

REFER ALSO TO CITATION(S) 56923

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

56204 (PB—265116) Heat extraction from hot, dry rock masses. Progress report 1 Feb-31 Jul 76. Weertman, J.; Achenbach, J.D.; Bazant, Z.P.; Dundurs, J.; Keer, L.M. (Northwestern Univ., Evanston, Ill. (USA). Materials Research Center). Oct 1976. 186p. NTIS PC A09/MF A01.

See also report dated Apr 76, PB-256 775.

Contents: Analytic study of crack growth and shape; Finite element solution of geothermal energy extraction; Fluid flow through cracks; Model experiments; Seismic detection of hydraulically induced fractures.

DIRECT ENERGY UTILIZATION

56205 Utilization of geothermal energy other than power generation. Sekioka, M. (Defense Acad., Japan). *Doryoku;* No. 135, 1-7(1975). (In Japanese).

With the exception of the Onikobe geothermal field, all Japanese geothermal power plants reclaim heat from the working fluid after it has passed through the generating cycle. The heat is transferred to river water or spring water and employed in domestic heating or commercial applications in nearby towns. Due to the number of natural hot springs and lack of demand, the excess hot water produced at Onikobe is reinjected. At the Hatchobara field 340 t/h of water at 92-93°C are produced and the heat is exchanged from 30 t/h for secondary use. At the Sujiyu hot spring, located 1 km from the Hatchobara field, river water is heated to 65-70°C and used in the hot water and heating/air conditioning systems of nearby hotels. At the Otake field, 370 t/h are produced at 93-95°C and 60 t/h are transferred for use in heating, cooking, bathing and greenhouses. At the Matsukawa field, 3.5 kg/m³ is produced at 183°C. Waste steam is used to heat 15 t/h of water to 70°C. The water is used in artificial hot springs in Hachimandaira, about 6 km from the field. At the geothermal fields of Hokkaido, Iwate, and Akita, hot water is transferred over distances of up to 60 km for use in snow melting, heating, greenhouses and aquaculture.

GEOTHERMAL DATA AND THEORY

56206 Flow of heat from the Earth's interior. Pollack, H.N.; Chapman, D.S. *Sci. Am.;* **237**: No. 2, 60-68, 73-76(Aug 1977).

The discussion is presented under the following section headings: measuring heat flow; heat flow and plate tectonics; global heat flow; the thickness of the lithosphere; and thermal history of the earth. A global heat-flow map was drawn on the basis of thousands of individual field measurements on continents and ocean floors. The heat-flow pattern is interpreted in terms of plate tectonics. JGB)

56207 World heat flow data collection, 1975. Jessop, A.M.; Hobart, M.A.; Sclater, J.G. Ottawa; Energy, Mines and Resources Canada (1976). 129p. and Publishing Supply and Services, Ottawa $3.60.

Both oceanic and continental heat flow data are included. Information is tabulated under the following headings: descriptive code; name of site; latitude and longitude; elevation; depth interval; number of temperature measurements; temperature gradient; number of conductivity measurements; average conductivity; number of heat generation measurements; average heat production; bottom-water temperature; heat flow; number of individual sites; reference; and date of publication. 338 references (JGB)

PROPERTIES OF AQUEOUS SOLUTIONS

REFER ALSO TO CITATION(S) 56189

56208 (USGS-BULL—1421-C) Volumetric properties of aqueous sodium chloride solutions from 0° to 500°C at pressures up to 2000 bars based on a regression of available data in the literature. Potter, R.W. II; Brown, D.L. (Geological Survey, Washington, D.C. (USA)). 1977. 42p. GPO $0.70.

The volumetric properties of aqueous sodium chloride solutions from 0° to 500°C at pressures up to 2000 bars for concentrations ranging from infinite dilution to as high as 8.0 molal were obtained by a computer regression of the available experimental data from the literature. The regression was done using (1) the simplest forms of equations capable of describing the experimental data, (2) unsmoothed data where possible, and (3) a least-squares regression technique in which the individual data points were weighted with respect to their relative uncertainty. By following this procedure, a set of internally consistent data was generated. The results are presented in 27 tables of density data at various concentrations, temperatures, and pressures. Two tables of empirical constants capable of generating the tables of density values as well as interpolating the tabulated values are also given.

56209 Procedure for estimating the temperature of a hot-water component in a mixed water by using a plot of dissolved silica versus enthalpy. Truesdell, A.H.; Fournier, R.O. *J. Res. U.S. Geol. Surv.;* **5**: No. 1, 49-52(1977).

A graphical method using a plot of dissolved silica versus enthalpy allows quick determination of the temperature of the hot-water component of a nonboiling thermal spring. The method is applicable to warm spring waters that either have not lost heat before mixing or have lost heat by separation of steam before mixing. 3 refs.

56210 Adsorption of metal ions on colloidal silica. Masuko, N. (Univ. of Tokyo, Inst. of Ind. Sci.); Mushiake, K. *Seisan Kenkyu;* **29**: No. 3, 28-32(1977). (In Japanese).

Studies were made of the adsorption of heavy metals on colloidal particles in order to predict scaling effects in geothermal power plants and to assist in the treatment of municipal water supplies. Previous studies have shown that the adsorption is due to reaction of silanols on particle surfaces and hydrated waters of heavy metal ions. It was found that adsorption occurred at a lower pH than precipitation. The pH value at which the adsorption curve rose was in general agreement with the precipitation curve. Adsorption of AsO at 0.0004 mol/l took place at a pH of approximately 2.5. At pH levels above 6.0 the desorption of AsO_2 tended to occur.

56211 Determination of trace elements in hot spring water by anode stripping voltametry. Ishii, T.; Katsuno, Y.; Yamazaki, K. *Mizu Shori Gijutsu;* **18**: No. 4, 319-326(1977). (In Japanese).

Hot spring water was analyzed by anode stripping voltametry. Atomic absorption spectrometry standards were used. Analyses of Zn and Cu were performed with three point standard addition and those for Cd and Pb with two point standard addition. The results of the tests are presented in both tabular and graphic form, together with commentary on the procedures followed. Six references are given.

PROPERTIES OF MINERALS AND ROCKS

56212 Equipment for investigation of physical properties of rocks and minerals at different high pressure intervals. Volarovich, M. N. *Gerlands Beitr. Geophys.;* **86**: No. 1, 62-68(1977). (In Russian).

During the preceding two decades, equipment for the investigation of the physical properties of rocks and minerals under high pressure conditions has been developed. This equipment constitutes an important part of current experimental research. Although the devices generally operate on the basis of such fundamental principles as the anvil, individual researchers often modify the equipment to meet their specific needs. They generally operate in fixed pressure ranges and are used to evaluate properties such as density, compressibility, elastic wave velocity and thermo-electro-magnetic effects.

ROCK-WATER-GAS INTERACTIONS

56213 Factors influencing crystalline form of calcareous sinters. Ishigami, T. (Tohoku Univ., Fac. Sci., Japan); Suzuki, R. *Chikyu Kagaku (Earth Sci.);* No. 11, 9-13(1977). (In Japanese).

Studies were made of the conditions giving rise to calcareous sinters, specifically to determine the factors controlling crystal morphology. Samples were taken from Kunimi Hot Springs in Iwate prefecture as well as several other springs. Factors influencing crystal morphology were the solution temperature, magnesium concentration and degree of $CaCO_3$ saturation. It was found that a high degree of $CaCO_3$ supersaturation favored the growth of aragonite. This behavior was independent of the solution temperature. At Kunimi Hot Springs, pure aragonite deposits form at a temperature of 31.5°C from water having a high Mg/Ca ratio and a high activity product.

ISOTOPE AND TRACE ELEMENT STUDIES

56214 Temperature and pressure of the Ryoke gneisses estimated by garnet-cordierite geothermometer. Ono, A. (Natl. Inst. for Res. in Inorganic Materials, Japan). *Ganseki Kobutsu Kosho Gakkaishi;* No. 72, 114-117(1977).

The chemical compositions of garnet and cordierite coexisting with sillimanite and quartz have been demonstrated to be useful in determining the temperature and pressure of metamorphism. A discussion is presented of the thermodynamic considerations applicable to this geothermometer. The technique was applied to samples of the Ryoke gneisses and the results indicate metamorphism at 600-650°C and about 450-500 MN/m^2.

TIDAL POWER

TIDAL POWER PLANTS

DESIGN AND OPERATION

56215 Tidal energy and system planning. Wilson, E.M. (Univ of Salford, Engl). *Consult. Eng. (London);* **41**: No. 4, 25(Apr 1977).

A different approach to look to the system to do the necessary regulation of the tidal scheme's energy production is discussed. Variation in cost/kWh of energy sent out from various sources at varying load factors is presented graphically.

56216 State of the art. Gwynn, J.D. (Eng and Power Dev Consult Ltd). *Consult. Eng. (London);* **41**: No. 4, 23(Apr 1977).

The means for investigation, design, execution, and operation of tidal energy utilization projects are reviewed.

WAVE ENERGY CONVERTERS

REFER ALSO TO CITATION(S) 56170

56217 Energy recovery from sea waves with the aid of oscillating floating bodies. Ferdinande, V. (Rijksuniv Gent, Belg). *Ingenieursblad;* **46**: No. 2, 42-49(Feb 1977). (In Dutch).

The theoretical mechanical energy of gravity waves and that of sea waves off the Belgian coast is discussed. The hydrodynamic theory of energy recovery from sea waves by means of floating bodies is considered and several projects of converting wave energy into usable energy are described. The conditions and possibilities of utilizing sea wave energy along the Belgian coast are examined. 13 refs.

56218 Forecast computation of maximum wave at Venice lagoon inlet entrances. Cavaleri, L. (CNR, Venezia, Italy). *Energ. Elettr.;* **53**: No. 10, 533-544(Oct 1976). (In Italian).

A forecast of wave motion under extreme conditions within lagoon inlets is presented. Given sea conditions off the coast according to Glenn, the wave energy spectrum deformations are studied during their approach to the coast as a result of refraction and shoaling phenomena. After having ascertained sea conditions at the inlets, propagation and deformation of individual frequencies are studied inside each one, up to a given cross-section. Energy spectrum, maximum and significant wave, and components of these magnitudes which are perpendicular to the section are presented for each given cross section at 50 m intervals (70 m for the Lido). 17 refs.

WIND ENERGY

ECONOMICS

56219 (TID—27698) **Wind energy mission analysis. Executive summary.** Coty, U. (Lockheed-California Co., Burbank (USA)). Oct 1976. Contract EY-76-C-03-1075. 31p. Dep. NTIS, PC A03/MF A01.

The Wind Energy Conversion Branch of The Energy Research and Development Administration undertook the task of determining the economic viability of wind energy conversion systems (WECS). A contract, AT(04-3)-1075 "Wind Energy Mission Analysis," was awarded to Lockheed early in 1975 and completed early in 1976. The results of this study are severely condensed and summarized in this executive summary to provide an overview of over 850 pages of report and appendices and over 1,000 pages of processed wind data.

56220 **Status of wind energy conversion systems (WECS) for electric utility power generation.** Johanson, E.E. (JBF Scientific Corp., Wilmington, MA). *Trans. Am. Nucl. Soc.;* 26: 2(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

WIND ENERGY ENGINEERING

REFER ALSO TO CITATION(S) 56109

APPLICATIONS

56221 **Temperature control system utilizing naturally occurring energy sources.** Tompkins, L.L. (to Xenco Ltd.). US Patent 4,015,962. 5 Apr 1977. Filed date 20 Dec 1974. 10p.

A temperature control system for an enclosed structure is disclosed which utilizes two circuits, one for heating and one for cooling the structure. The system makes maximum use of naturally occurring sources of energy, such as wind and solar heat to provide the requisite heating or cooling. Wind driven compressors, one in each circuit, provide the motive force for the heating and cooling fluid in the closed loop circuits. The cooling circuit transfers heat to the heating circuit to minimize unutilized energy. A storage unit is provided to store heat or low temperature fluid when heating or cooling of the structure is not immediately required. 17 claims, 3 figures.

TURBINE DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 56220

56222 (SAND—76-0131) **Wind tunnel performance data for two- and three-bucket Savonius rotors.** Blackwell, B.F.; Sheldahl, R.E.; Feltz, L.V. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jul 1977. Contract EY-76-C-04-0789. 107p. Dep. NTIS, PC A06/MF A01.

Fifteen configurations of a Savonius rotor wind turbine were tested in the Vought Corporation Systems Division 4.9- x 6.1-m Low Speed Wind Tunnel to determine aerodynamic performance. The measured test variables were torque, rotational speed, and tunnel conditions. The data presented are in the form of power and torque coefficients as a function of speed ratio (or angular position for static starting torques). It is concluded that increasing Rynolds number and/or aspect ratio improves performance. The recommended configuration consists of two sets of two-bucket rotors, rotated 90° apart, with each rotor having a dimensionless gap width of 0.1 to 0.15.

56223 **Rotor for wind-driven machine.** Moran, K.E. US Patent 4,025,233. 24 May 1977. Filed date 12 Apr 1976. 6p.

In the rotor of a windmill electric generator, blades are secured to a hub by means of individual tab-receiving slots and a common "knock-off" hubcap, this mounting means providing for rapid assembly and disassembly. The mounting structure itself establishes a predetermined pitch at the blade root, thus permitting the advantages of an optimum twisted blade to be obtained without the need for an excessively complex blade configuration. The result is a compact generator unit that can be used easily in remote areas and stowed with camping equipment. 5 claims, 4 figures.

56224 **Aeolian windmill.** Payne, P.R. US Patent 4,024,409. 17 May 1977. Filed date 7 Jan 1977. 8p.

A system is disclosed which utilizes a member which oscillates in response to movement of a fluid past it and a means for utilizing the energy generated by the oscillation. In one embodiment the oscillating member is a cable utilizing wind or water as generator or pump. In a second embodiment, the oscillating member is an airfoil having either pitch control or active circulation control. 7 claims, 11 figures.

56225 **Higher efficiency wind motor with receptors of diminished drag characteristics.** Darvishian, A. US Patent 4,015,911. 5 Apr 1977. Filed date 28 Jul 1975. 8p.

A wind motor for the conversion of wind power to mechanical or electrical power or other form thereof is described which includes a plurality of wind receptors which have openings therein for the passage of air therethrough during operation of the wind motor, especially when the receptors are moving against the wind, so as to diminish air resistance (drag) opposing such movement, thereby increasing the efficiency of the wind motor. 7 claims, 2 figures.

SITE CHARACTERISTICS

56226 **Estimating wind power potential.** Baker, R.W.; Hennessey, J.P. (Oreg State Univ, Corvallis). *Power Eng.;* 81: No. 3, 56-57(Mar 1977).

Tests of the Widger method at four Pacific Northwest locations show that accurately estimating the shape of wind speed distribution is critical, and that an empirical method of wind speed measurement may not be usable at good wind power sites.

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 55568, 56365, 56977

56227 **Simultaneous load analysis of an electricity and district-heating supply system.** Loh, W.P. (Wibera, Duesseldorf, Ger). *Fernwaerme Int.;* 6: No. 1, 1-4(Mar 1977). (In German).

The analysis of the time behavior of the power requirement for system input (also called load) is the basis of many studies made by supply undertakings for planning purposes. The planner wishes to know how frequently the cases of loading occur. As an aid in characterizing the time of utilization of supply plant, duration curves are often used. On this basis a computer-based form of presentation is developed for two-dimensional load variations, as they occur in power stations, heat-electric stations and heating stations working in combination for electricity and district-heating supply. By using this method comprehensive loading data can be converted into an understandable form which is suitable for further investigation.

56228 **Gas turbine power plants of large unit capacity in standard construction.** Lange, K.H.; Heinecke, H.J. (Kraftwerk Union, Berlin, Ger). *Am. Soc. Mech. Eng., [Pap.];* No. 77-GT-21, 1-6(1977).

Contrary to the common practice in the U.S.A. it was usual in Europe to build gas turbine power plants individually. Kraftwerk Union AG now reports on a new pre-engineered standard concept which has been designed by its Engineering Department. The pre-engineered concept and the standardization of conponents are described. The possibility of extending this standard plant to a KWU Exhaust Heat Recovery Plant is indicated.

56229 **Results and problems of the new system of planning, financing and economic stimulation of research for development of new power engineering equipment.** Kolyada, G.I.; Feigin, S.E.; Khabanova, E.M. *Energomashinostroenie;* No. 1, 31-33(1977). (In Russian).

The work of the USSR Ministry of Power Engineering regarding the development of new machinery for power plants, under the conditions of the newly introduced system of planning, financing and economic stimulation, is reviewed.

56230 **Power engineering branch system of scientific and technical information in the tenth five year plan period.** Granovskii, Ya.L. *Energomashinostroenie;* No. 1, 33-34(1977). (In Russian).

The Scientific Research Institute of Economics, Organization of Production and Scientific and Technical Information (NIIEinformenergomash) has been set up as the center of scientific and technical information of the Soviet power engineering industry. Its work is described. Inter alia, it contains a system of selective distribution of information. According to this system, about 200 subjects are systematically covered. RandD workers get about 25,000 punched cards with information about new information material, 900 translations of foreign information, over 200,000 copies of articles from different sources, etc. An automatic information retrieval system is to be introduced. The number of subjects covered is to be increased to 3000 by 1980.

56231 Generation game. *Engineering (London);* **216**: No. 12, 880-883(Dec 1976).

The article reviews the present state and some future plans for generating electricity in England and Wales. In England and Wales almost all of the potential water sources have already been exploited to the full; in any case they account for less than 1% of the total generated. Nuclear stations now produce about 12%, gas about 3%, oil about 10% and coal 75%. This means that about 88% is dependent on ever changing fuel prices. Because of the present competitive price of coal over oil, the Central Electricity Generating Board (CEGB) are faovring coal: the estimates for 1976/7 are 69M tonnes of coal (an increase of 6Mt) and about 13Mt coal equivalent of oil--a reduction of around 50%. Nuclear stations represent less than 7% of total generating capacity but due to their low costs are meeting a larger proportion of the load. Relative cost figures for 1975/6 are nuclear 0.67p/kWh; coal fired, 0.97p and oil fired 1.09p. Out of the 161 power stations operating in England and Wales in March of 1976, 114 are wholly or partly fired by coal, 24 entirely by oil and 8 are nuclear. The equation of storage of generated energy is expected to be important in the foreseeable future because nuclear plants should run continuously. Some possibilities being considered include using off-peak power to produce hydrogen which would then be fed to a distribution network of mains and/or stored as liquid or underground as gas. Subsequently it could either be used directly as a fuel, synthesised into a light hydrocarbon or re-converted to electricity by some form of fuel cell. Other possibilities are compressed air storage, or superconducing storage, which last is being studied at the Los Alamos Scientific Laboratory. At present all are rather costly, and none has reached a practical stage. For power transmission, high-voltage dc systems look promising.

56232 Multifactorial model of technical and economic indices of performance of thermal power plants. Guzhov, N.P.; Puchkov, V.S. (Sib Sci Res Inst of Energet, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 10, 102-106(Oct 1976). (In Russian).

The possibility of using factorial analysis methods to construct a stochastic model of technical and economic indices of operation of thermal electric power plants is considered. Evaluations of the exactness of functioning of a multifactorial model both within a considered interval of time and for a predicted period are carried out. Statistical data of a particular electric power system are utilized in the calculations.

56233 Utilization of exergy function in mathematical modeling of thermal power plants. Nozdrenko, G.V. (Novosibirsk Electrotech Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 10, 139-143(Oct 1976). (In Russian).

A method of using the exergy function for mathematical modeling in a computer of thermal power plants is set forth. This approach may be useful when developing mathematical models of functioning of district heating installations (and in some cases of condensing plants, too) of thermal power plants and of fuel overconsumptions, load distribution, process control etc. Application of the method is illustrated on the example of a problem of control of the process of air feeding to the furnace of a Pp--950--255-type steam generator. 14 refs.

56234 Efficiency of production of heat and electric power at heat-and-power central stations. Plir, A.E.; Kuntysh, V.B. (Arkhangel'sk Forest Ind Inst im. V.V. Kuibyshev, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 10, 129-133(Oct 1976). (In Russian).

The cycle of a district heating plant is considered as a combination of the direct cycle, in which electric power production takes place, and of the reverse cycle of a heat pump, in which production of heat takes place. Starting from the 1st and 2nd principles of thermodynamics, it is shown that heat consumptions for the production of electric power by the condensing and district heating steam flows are similar, and that fuel economy at a heat-and-power central station is achieved as a result of a reversible transformation of heat, applied to the working medium, into low-potential heat required by the heat consumer.

56235 Thermodynamic analysis of the work of heat-and-power turbine plants with sliding initial steam pressure. Ivanov, V.A. (Leningrad Polytech Inst im. M.I. Kalinin, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 10, 61-66(Oct 1976). (In Russian).

A thermodynamic analysis of the operation of heat-and-power turbine plants without and with intermediate steam superheating, subject to a combined control program (constant pressure at high flowrates and sliding one at low flowrates), is presented. It is shown that the entire gain for plants without intermediate superheating is attained only with condensing steam flow. The turbine plants with intermediate superheating show a thermodynamic gain both with condensing and district heating steam flows.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

56236 (BNWL—2122) Study of the comparative costs of five wet/dry cooling tower concepts. Zaloudek, F.R.; Allemann, R.T.; Faletti, D.W.; Johnson, B.M.; Parry, H.L.; Smith, G.C.; Tokarz, R.D.; Walter, R.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1976. Contract EY-76-C-06-1830. 106p. Dep. NTIS, PC A06/MF A01.

The projected cost of five alternative dry/wet power plant heat rejection concepts was studied under conditions imposed by hypothetical use in association with the San Juan Plant Unit 3, a 550-MWe facility currently under construction near the "Four Corners" area of New Mexico. The five alternative concepts were: integrated dry/wet tower; separate dry and wet towers; metal fin-tube induced draft tower with deluge water augmentation; plastic heat exchanger tower with deluge water augmentation, and metal fin-tube/deluge augmentation tower with an intermediate ammonia evaporation-condensation condenser and the cooling tower. The integrated dry/wet tower concept, already chosen for service at San Juan Unit 3, was included for reference purposes. All concepts were conceptually designed and estimated using the same bases and employing uniform practices. Each concept was assumed to use all water allocated for consumptive use in Unit 3. The cost estimates obtained showed the following descending order of "comparable capital cost": separate dry/wet; metal fin-tube/deluge; integrated dry/wet; plastic tube/deluge; and metal fin-tube/deluge/ammonia. The results indicate that two of the advanced concepts considered, i.e., the plastic tube/deluge concept and the metal fin tube/deluge/ammonia concept, can possibly reduce the overall costs of dry/wet cooling under conditions imposed by the site considered. It was recommended that these two concepts receive additional attention by the ERDA Dry Cooling Tower Program and industry to further quantify their potential benefits and demonstrate their performance and reliability.

56237 (BNWL—2268) Overview of economic, legal, and water availability factors affecting the demand for dry and wet/dry cooling for thermal power plants. Hendrickson, P.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jun 1977. Contract EY-76-C-06-1830. 65p. Dep. NTIS, PC A04/MF A01.

The economic, legal, and water availability factors which will contribute to selection in the future, of dry and wet/dry cooling vis-a-vis other methods of cooling and which will influence the projected market for these types of cooling systems in the next twenty years are considered.

56238 New designs in currently marketed cooling towers. Lindahl, P.A. Jr. (Marley Cooling Tower Co., Mission, KS). *Trans. Am. Nucl. Soc.;* **26**: 112(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56239 EPRI Research Program in cooling tower technology and environmental impacts. Maulbetsch, J.S. (Electric Power Research Inst., Palo Alto, CA). *Trans. Am. Nucl. Soc.;* **26**: 112-113(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56240 Design study of cooling tower drift eliminators. Chan, J.K.; Golay, M.W. (Massachusetts Inst. of Tech., Cambridge). *Trans. Am. Nucl. Soc.;* **26**: 113-114(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56241 Engineering and cost comparison of three different all-dry cooling systems. Braun, D.J. (Battelle Pacific Northwest Lab., Richland, WA); Braun, D.J.; Faletti, D.W.; Fryer, B.C.; Johnson, B.M.; Wiles, L.E. *Trans. Am. Nucl. Soc.;* **26**: 116(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56242 Influence of temperature stratification on the thermal performance of a dry cooling tower with natural draught. Buxmann, J. (Tech Univ, Hannover, Ger). *Brennst.-Waerme-Kraft;* **29**: No. 3, 90-94(Mar 1977). (In German with English abstract).

The cooling effect of a cooling tower is noticeably changed, if in its surroundings there exists a temperature stratification which is different from the adiabatic temperature stratification. The design data are investigated which have an influence on the heat rating and the total temperature difference at various temperature gradients in the air.

56243 Noise characteristics of reducing and cooling installations. Robozhev, A.V. (Moscow Power Eng Inst, USSR). *Teploenergetika (Moscow);* No. 10, 52-56(Oct 1976). (In Russian).

Some data on natural-size tests of reduction and cooling installations at two heat-and-power plants are presented. Noise measurements were made with loads between 10 and 100%. The experimental data show that the noise level generated by the reducing and cooling installations is very high, exceeding permissible health standards. Some recommendations on reducing the noise level are given.

POWER CYCLES

56244 (CONF-760503—P1, pp 431-436) **Role of alkali metals in energy conservation.** Rajakovics, G.E. (Vereinigte Edelstahlwerke AG (VEW), Kapfenberg/Seibersdorf, Austria); Schwarz, N. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The improvement of thermal power station efficiency becomes imperative with regard to energy conservation. Thermal efficiency can be improved by raising the top temperature as well as by adjusting the actual reversible process to the Carnot cycle. This cannot be realized solely with the conventional steam process, and the only approach to better efficiency lies in combining conventional steam with topping cycles. From the thermodynamic point of view, Rankine cycles are superior to Brayton cycles for topping purposes. The realization of such topping Rankine cycles in the high-temperature field is only possible with alkali metals as working fluids. Alkali metal topping cycles with well known materials will allow top temperatures of about 800°C to 900°C and yield about 50 percent overall power station efficiency. The "Treble Rankine Cycle Process (T.R.C.P.)", which further uses a diphenyl process between potassium and water process, will even achieve 56 percent T.R.C.P. has the best efficiency of all processes practicable in this temperature field.

56245 (FE—2290-27) **High temperature turbine technology program. Phase I. Program and system definition. Topical report: fuels cleanup and turbine tolerance.** (Westinghouse Electric Corp., Lester, Pa. (USA). Generation Systems Div.). Feb 1977. Contract EX-76-C-01-2290. 284p. Dep. NTIS, PC A13/MF A01.

Westinghouse in-house information and the literature were examined to assess deposition, corrosion and erosion information and its applicability to the High Temperature Turbine Technology Program. It was determined that tolerances could be estimated for corrosion and erosion; however, there is insufficient deposition data to establish the level and size of particulates that the turbine can ingest and be assured of satisfactory electric utility operations. A review of gasification systems, including hot- and cold-gas cleanup was made, to examine the alternatives available and compare the various systems. A gas cleanliness prediction was made for the IGT U-Gas gasifier system (OPDD system) with a cold-gas cleanup designed by Foster-Wheeler and the advanced Westinghouse gasifier system with hot-gas cleanup. The cold-gas cleanup system was more effective in removing ammonia and alkali metals. Significant experimental work is needed to validate the predictions. The OPDD system was found to meet the present-day steam power plant emissions regulations and very nearly meet the advanced target regulations. The cold-gas cleanup system produced results within the turbine tolerance range for corrosion and erosion. The turbine tolerance for deposition must be determined with carefully planned experimental programs. A review was made of current gas composition measuring techniques which will play an important role in future experimental programs.

56246 Layout of a scheme of combined diesel engine and turbine plants. Prikhod'ko, M.S.; Gologorskii, I.D. *Energomashinostroenie;* No. 11, 40-42(1976). (In Russian).

An analysis of the supercharging system of a diesel engine with an intermediate exhaust gas afterburning chamber and a cooled radial turbine is presented.

WASTE-FUELED SYSTEMS

56247 Incineration of domestic refuse: experience in Germany. Thoemen, K.H. *Chart. Mech. Eng.;* **23**: No. 11, 50-52(Dec 1976).

Data on the utilization of heat from FRG refuse incineration plants is given as follows: 11 plants, totaling 2,881,000 ton/yr, are integrated into power plants and/or used in compound power plants; 8 plants, totaling 1,039,000 ton/yr, combined heat and power plants with power generation and external heat distribution; 7 plants, totaling 626,000 ton/yr, generate heat for external heating systems. The special design problems of incinerators are described. For example, up to now, grate stokers have shown the best performance and there are three principal types employed for medium-sized and large plants. These are the reciprocating grate (System Martin), the forward feeding grate (System von Roll) and the roller-grate (System Duesseldorf). The two basic forms of furnace construction are parallel-flow and counter-flow. The choice depends on the composition of the refuse; waste with low calorific value, and bad overall combustion characteristics, is difficult to burn and part of the heat must be fed back into the fuel bed. A counter-flow furnace is therefore best, especially when it is uncooled. The flue-gas in this kind of furnace is led over the fuel bed in the opposite direction to the direction of fuel transport. Waste with a high calorific value or overall good combustion character, does not need this support. In this case it is better to install a parallel-flow furnace and it might even be necessary to cool the furnace by the installation of waterwalls. In addition, the feasibility of waste heat utilization, operating experiences, and measures taken to control boiler tube corrosion, are discussed.

56248 Incineration of domestic refuse: refuse into energy at Sheffield. Holmes, J.R. *Chart. Mech. Eng.;* **23**: No. 11, 53-55(Dec 1976).

The Sheffield refuse incineration plant is the fourth steam raising heat recovery plant in the UK. It is mentioned that this plant is in the main stream of European thinking, where to a much greater degree than the UK, refuse is used to generate electricity and provide district heating. The plant is a two-stream * 10 ton/hr unit fitted with steam-raising boilers of conventional water tube design. A large storage bunker ensures an adequate reserve of fuel over weekends and other intervals between deliveries. The maximum evaporation rate of each boiler is 31.8 tons of steam with an estimated boiler efficiency of 57.8 %. When burning refuse with an average gross calorific value of 11 000 kJ/kg, each furnace stream will produce 24.4MW or 5.7×10^7 kJ/h continuous maximum output of useful heat for export. The boiler input temperature is 760°C and the maximum gas temperatures at the entry to the precipitators 294°C. A magnetic separation for ferrous metal recovery is positioned adjacent to the head end of the ash belt conveyor from each incinerator. Steam from the incinerator plant with supply district heating for a government housing development 760 m away from the incineration plant. It contains 2309 private dwellings, 26 shops and 17 public and quasi-public buildings, factories, offices, etc. The refuse-based scheme required few modifications to the existing pipework and boilers and in essence involved the tapping in of flow and return mains from the incinerator and its heat exchangers into the existing primary circuits. The boiler houses are on full standby in case of failure or malfunction. Income from heat exported and ferrous metals recovered is expected to bring the net operating costs of incineration down to about 3 pounds per tonne.

56249 Incineration of domestic refuse: power from refuse at Kynoch works. Marshall, J.E. (IMI, Engl). *Chart. Mech. Eng.;* **23**: No. 11, 55-57(Dec 1976).

The cost of energy is an important factor in many industries and at the IMI Kynoch Works in Birmingham (England) there is a history of providing energy from the cheapest possible source, whatever that source was. This article describes the use of refuse as a secondary fuel providing power through conventional boilers. Refuse is received from the West Midlands Metropolitan County Council vehicles which tip into a reception hopper fitted with a slat conveyor. The slat conveyor, by virtue of its angle of inclination, provides a steady feed rate into the mouth of a conventional shredding mill. A conveyor elevates the shredded refuse to a height of approximately 6 m and at the discharge point ferrous scrap is separated out by an in-line overband magnetic separator. shredded refuse minus 80 percent of the ferrous material then travels into one of six demountable containers. Loading is carried out by a helical screw which moves and compresses the shredded refuse so that each container carries 6 tons. Containers are tipped at the Power Station and a conveyor, driven by a variable speed unit, controls the refuse feed rate into the boiler. Cutting screws in the roof of the hopper reduce the mass of shredded refuse to a uniform height of 150 mm from an initial height of 2.5 m. Shredded refuse is conveyed to one of two burners at the rear of the boiler and is blown over and onto the coal fire on the chain grate. Eight tonnes/hr of shredded refuse represents approximately 50% of the heat input into the furnace, the design refuse-to-coal ratio. Ferrous metal extraction regularly achieved 6% by weight of the incoming raw refuse and no difficulty was experienced in its sale. The company is providing primary energy in a boiler at an all-in cost approximately 60% of conventional fuel costs. The process requires no financial contribution from the community who will benefit by their release from existing disposal charges.

COMPONENTS

REFER ALSO TO CITATION(S) 55720, 55729, 56245, 56347, 56667, 56671, 56684, 57098, 57121, 57124, 57132, 57137, 57319

56250 (FE—1765-30) **High temperature gas turbine engine component materials testing program. Task 1. Quarterly technical progress report No. 7, January 1—March 31, 1977.** Cutrone, M.B. (General Electric Co., Schenectady, N.Y. (USA). Gas Turbine Div.). 15 Apr 1977. Contract EX-76-C-01-1765. 48p. Dep. NTIS, PC A03/MF A01.

Resumption of initial liquids testing was delayed by OSHA requirements for construction of a catch basin around the fuel tank area and by curtailment of natural gas to CR and D test facilities. The natural gas restriction was lifted in March. Creosote fuel has been received, analyzed and shipped to Hydrocarbon Research, Inc. (HRI) for doping with H-coal sludge. Testing is expected to resume in early May. Fabrication of the confirmation test air cooled nozzle cascade is underway, with EDM drilling of cooling holes in process at Windsor Corporation. Screening tests continued throughout the reporting period. Additional corrosion discs have been removed, metallographically examined and penetration rates observed.

56251 Total energy merseyside power station extension. *Energy Dig. (London)*; 6: No. 1, 21-23(Feb 1977).

The Merseyside Power Station on Bromborough Port Industrial Estate is operated by UML Limited, the Unilever services company on Merseyside. Its main feature--particularly significant in these days of world energy shortages and continually increasing fuel prices--is in being a dual energy station which produces both steam and electricity. The station provides steam supplies to some 15 local companies and the electricity requirements of nearly 50. As the load developed in the early 1960s the original four 45 ton/h 45 bar, 450°C boilers and 14 MW of back pressure electrical generation became inadequate to meet the needs and in 1966 an additional 104 ton/h 103 bar, 538°C boiler and 13MW of electrical capacity were commissioned. By the 1970s it became evident that consideration should again be given to extension of the station as some of the original Central Power Station plant which had been used as stand-by was nearing the end of its useful life, and the system load was continuing to grow. After consideration of various possibilities it was decided that the requirements could best be met by the provision of a second 104 ton/h boiler and a 5.8MW 102/45 bar back pressure turbo-generator. The new oil-fired boiler, water-treatment system and generating plant are described. Steam and water pipework systems are interconnected with the existing station pipework at all pressures from 1.4 bar to 45 bar on steam. and 3.4 bar to 141 bar on water. The plant operates at an annual thermal efficiency of 78% and thus also makes valuable contribution to energy conservation.

56252 Problems of improving steam turbine seals. Kosyak, Yu.F.; Orlik, V.G.; Rozenberg, S.Sh.; Skomorovskii, A.Z. (Cent Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 1, 42-45(Jan 1977). (In Russian).

Recommendations to improve economic efficiency and reliability of high-capacity steam turbines are presented. They take into acccount specific features of operation of their seals.

56253 Operation of the K-200-130 turbine in motor regime conditions. Kiselev, G.P.; Zaryankin, A.E.; Vedyaev, V.A.; Arakelyan, E.K. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 1, 45-48(Jan 1977). (In Russian).

Some results of experimental and theoretical investigations of the operation of the K-200-130 steam turbine, made by Leningrad Metal Works, in motor regime conditions, are presented. A working model of the cooling steam operation in the flow-through part of the turbine is proposed. Equations are obtained permitting determination, in particular conditions of operation, of the flowrates of the cooling steam in the medium-pressure and low-pressure cylinders and of the costs of implementation of the motor regime at the power unit.

56254 Refinement of the regime of chemical cleaning of k-300-240 KHTZ turbines under load. Kleimenov, N.G.; Andryushin, V.M.; Korzhov, E.N.; Agapova, A.V. (ORGRES, USSR). *Teploenergetika (Moscow);* No. 1, 52-56(Jan 1977). (In Russian).

Results of 15 chemical cleanings of four turbines under load by a trilon B solution and compositions are summmarized. The experiments have established high efficacy of washing copper and iron oxides out of the turbines without damaging them. The method of washing and the scheme of introduction of the reagent into the turbine are refined. Recommendations on the introduction of washing of turbines under load are given.

56255 Increasing service life of steamlines by repeated heat treatment of pipes. Trusov, L.P.; Mirkin, I.L.; Bogatyrev, Yu.M.; Eremina, V.P.; Uporova, V.A.; Guterman, M.B. (Cent Sci Res Inst of Heavy Mach, USSR). *Teploenergetika (Moscow);* No. 1, 65-68(Jan 1977). (In Russian).

A technology of heat treatment with induction heating of pipes made of 12 Cr 1 Mo V steel, which have been in operation for a long period of time, is proposed. Based on a comparative investigation of the structure and materials prior to and after heat treatment, the possibility of increasing the service life of steamlines made of this steel is shown.

56256 Protection of boiler steels from corrosion in solutions of trilon b and organic acids at temperatures of 100-170°C. Balezin, S.A.; Glikina, F.B.; Shadrina, N.I.; Bychkova, N.A.; Vinogradov, Yu.A.; Kutikov, A.R. (Moscow Inst of Geol Explor, USSR). *Teploenergetika (Moscow);* No. 1, 68-70(Jan 1977). (In Russian).

It is found that, in order to effectively protect boiler steels from corrosion at elevated temperatures (above 150 C), it is necessary to add, to the solutions of compositions, a mixture of inhibitors consisting of a sulfur-containing substance and acidic pickling inhibitors, for instance captax and catapine.

56257 Determination of optimal characteristics of plate-rib heat exchangers. Yakushin, A.N. *Teploenergetika (Moscow);* No. 1, 83-85(Jan 1977). (In Russian).

An analytical method of determination of the characteristics of an optimal plate-rib heat exchanger is presented. The possibility of existence of a heat exchanger with a minimal mass or volume is analytically proved. An analytical investigation of optimal heat exchangers is carried out.

56258 Importance of experience in scale removal. *Energie;* **29**: No. 1, 14-18(Jan 1977). (In German).

Various methods in current use for cleaning of the piping systems in power plants are assessed. It was concluded that this task should be given to a specialized and experienced contractor, because of the lack for general guidelines in cleaning and pickling of deposited scale in boiler tubes and piping system.

56259 Typical applications of the gas turbine. Zubler, R.; Bruggisser, A.; Kovacs, P. *Brown Boveri Rev.;* **64**: No. 1, 12-22(Jan 1977).

Gas turbines are installed in regions greatly differing geographically, e.g., in industrialized countries, in desert regions or on sea coasts. The frequently extreme conditions at the respective locations can be met only thanks to the special properties of the gas turbine, such as flexibility, simple operation and servicing, adaptability with respect to fuel. As an example of the versatility of the gas turbine, a description is given of three gas turbine power stations in three continents with different service conditions. These are the 100 Mw base-load power station Riyadh 4 (Saudi Arabia), the power station at Bochum-Hiltrop (Fed. Rep. of Germany), and the peak power station Maputo (Mozambique), all of which started operating in the course of 1975. Initial operational results are reported.

56260 Experience with a type 9 gas turbine in Iran. Winiger, H. *Brown Boveri Rev.;* **64**: No. 1, 23-26(Jan 1977).

A type 9 gas turbine has been running since February 1974 in the power station of the City of Shiraz. Up to August 5, 1976, this turbine has produced 194,770 Mwh during 16,854 running hours. During the first overhaul (April-May 1976) the turboset was found in generally good condition. This contribution describes the performance of the set in service and the condition of the parts at overhaul.

56261 Brown Boveri air-storage gas turbines. Zaugg, P.; Hoffeins, H. *Brown Boveri Rev.;* **64**: No. 1, 34-39(Jan 1977).

Air-storage gas turbine power stations correspond to hydraulic pumped-storage power plants. Their advantage over the latter is that they can be built in flat country. Previous publications about air-storage plants mostly dealt with the installation as a whole. The present article describes in particular the gas turbine developed by Brown Boveri for such installations.

56262 Corrosion and its prevention in modern stationary gas turbines. Felix, P.C. *Brown Boveri Rev.;* **64**: No. 1, 40-46(Jan 1977).

What is known as high-temperature corrosion has become a significant problem in the design of gas turbines, due to temperature increases in the attainment of higher outputs and improved efficiency. This article discusses the reasons for this, also possible sources of corrosion and their consequences, as well as means of combating them. Based on operational experience gained by Brown Boveri with gas turbines, it is shown that corrosion can be kept under control even in extreme conditions, by cleaning the fuel and air, by using suitable blade materials and protective coatings, as well as by using additives.

56263 Cooling of gas turbines blades. Mukherjee, D.K. *Brown Boveri Rev.;* **64**: No. 1, 47-51(Jan 1977).

Due to the high inlet temperature of gas turbines, the blades in the first rows have to be cooled. Using appropriate methods of cooling. Brown Boveri have succeeded in achieving a high cooling efficiency. Sophisticated computer programs are used in the design of blades and to predict the useful life of blading. Exhaustive experimental studies have confirmed the suitability of the method of calculation.

56264 Development of brown boveri gas turbine compressors. Farkas, F. *Brown Boveri Rev.;* **64**: No. 1, 52-59(Jan 1977).

The advent and propagation of gas turbines has been made possible only by the development of axial-flow compressors. The first Brown Boveri compressor of this type was tested almost 50 years ago. The historical evolution of this type of machine is explained in the light of its main parameters. The author concludes this report by certain comments concerning modern methods of calculation employed in connection with axial-flow compressors.

56265 Flow in exhaust gas diffusers. von Rappard, A. *Brown Boveri Rev.;* **64**: No. 1, 60-63(Jan 1977).

Relative to the effective power resulting from the difference between the turbine shaft output and the power input to the compressor shaft, the flow losses in the components are more important with gas turbines than with steam turbines. Considering the flow in an exhaust gas diffuser by way of example, paper assesses the connection between the changes of state in an exhaust gas system and in turbine blading. It shows, in particular, that the pressure recovery obtainable in the exhaust gas diffuser must be taken into account at the design stage of the turbine blading.

56266 Measuring vibration on turbine blades by optical means. Roth, H. *Brown Boveri Rev.;* **64**: No. 1, 64-67(Jan 1977).

Following an examination of present-day measuring systems for blade vibration in turbomachines, particular reference is made to 'momentary' processes, which enable all the rotating blades of a row to be observed from the casing for possible damage by vibration. Within this class of measuring systems, optical methods deserve primary consideration, as they alone achieve the high accuracy required. The principle of an optical measuring instrument developed for thermal machines is explained and tests reported on. This system is adaptable, making it universally suitable for investigating all types of vibration in rotating blades.

56267 Experience with gas turbines fired with blast-furnace gas. Pfeninger, H. *Brown Boveri Rev.;* **64**: No. 1, 74-86(Jan 1977).

In gas turbines run on blast-furnace gas and coupled with a generator and/or blast blower, the varying composition of the dust in the blast-furnace gas led to unexpected corrosion of the turbine blading in a number of machines. With scientific research the cause was identified and steps were taken to deal with the problem by the development of an anticorrosive coating which is applied to the surface of the blades. Several of these machines have by now logged more than 100 000 hours service. Experience with the problems of corrosion, contamination and the new protective coating has undoubtedly contributed to the latest developments in gas turbines. Particularly valuable is the experience gained with blast-furnace gas, as the combustion of fuels with low calorific value--produced by gasification of coal or heavy fuel oils--is being seriously reconsidered today.

56268 Heat treatment of large-sized welded steam turbine rotors for nuclear power plants. Kutasov, R.F.; Mukhina, M.P.; Tustanovskii, A.S. *Energomashinostroenie;* No. 1, 6-8(1977). (In Russian).

The equipment, auxiliary outfit, and heat treatment of large-sized rotors after welding is described.

56269 Investigation of stability of asymmetrically supported rotors. Kovalev, I.A. *Energomashinostroenie;* No. 1, 8-10(1977). (In Russian).

The dependence of the stability limit of a high-capacity turbine on the characteristics of rotor bearings is considered. Data of the calculation of the stability limit and results of experimental investigations are presented.

56270 Analysis of the three-dimensional boundary layer in centrifugal impellers of turbomachines. Shkarbul', S.N.; Bal'chuk, V.S. *Energomashinostroenie;* No. 1, 14-16(1977). (In Russian).

Problems and results of experimental and theoretical investigations of the flow of a viscous fluid in rotating rotors are considered. A flow model is presented. The method of calculating the three-dimensional layer is refined as a result. A device and a method of investigation by bleeding a coloring agent into the flow for the purpose of visualization are described. 9 refs.

56271 Optimization of the initial gas temperature of peaking gas turbine power plants. Shelud'ko, L.P.; Obmoin, V.V.; Chirkin, V.L. *Energomashinostroenie;* No. 1, 19-22(1977). (In Russian).

A method of calculation of the economically optimal gas temperature and of the motor potential of peaking gas turbine power plants is set forth. Account is taken of the main design characteristics and operating conditions of gas turbines. Examples of calculation of the optimal gas temperature and motor potential are presented.

56272 Investigation of a turboseparator with a freely rotating impeller. Kirillov, I.I.; Faddeev, I.P.; Rozin, V.S. *Energomashinostroenie;* No. 1, 29-30(1977). (In Russian).

An experimental setup and results of investigation of a turbogenerator with a freely rotating rotor is presented. The experiments confirmed the influence of moisture, circumferential velocity, flowrate, as well as design factors on the efficacy of separation. Experiments were carried out on a humidified air mixture.

56273 Raising the reliability of boiler units by improving the quality of welding of the heating surfaces. Parshin, A.A.; Gaponenko, L.N.; Korsunov, V.M. *Energomashinostroenie;* No. 1, 34-37(1977). (In Russian).

The ways to improve the operational reliability of boiler units by reducing the number of welded pipe joints and improving the technology and welding equipment are considered.

56274 Experience of vibrational detuning of blading. Karpin, E.B.; Arkad'ev, D.A.; Temkin, S.G. *Energomashinostroenie;* No. 1, 40-41(1977). (In Russian).

Results of strain gage tests of the fifth stage of the OR-12P turbine for driving feeding pumps are considered.

56275 Stamping unique blades from titanium alloys. Shastin, E.G.; Pisarenko, V.S.; Men'shikov, B.S.; Kuperman, D.I. *Energomashinostroenie;* No. 1, 42-44(1977). (In Russian).

The experience of starting the manufacture of unique blades for the K-1200-240 turbine by the method of stamping is described.

56276 Problems and prospects of development of gas turbine power plants. Andryushchenko, A.I.; Saprykin, G.S. (Saratov Polytech Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 1, 45-50(1977). (In Russian).

The state-of-the-art of the development of gas turbine power plants is reviewed and the expected performance and technical and economic indices of some promising peaking gas turbine plants are determined. The tasks with regard to their further imporvement are formulated. It is concluded that, at present, it is most expedient to design gas turbine plants based on the simplest cycle, with an elevated gas temperature and--under certain conditions--with regeneration. Their types should be reduced to the minimum. They should be adapted to burn residual fuel oil. 13 refs.

56277 Method of compiling algorithms and programs for digital computers to optimize load distribution among turbine units of heat-and-power stations. Vinogradnik, M.V.; Kurnosov, A.T.; Klimovskikh, E.S. (Dnepropetrovsk Eng-Constr Inst, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 1, 80-84(1977). (In Russian).

A method of optimal load distribution between turbine units of heat-and-power plants by means of a computer is worked out. The main principles of the method are described and an example of its application to a particular heat-and-power station scheme is presented. It is shown how to apply the computer-aided calculation programs compiled in accordance with the above method.

56278 Fiat HI-control system for Fiat gas turbines. Giordano, G. (FIAT, Torino, Italy). *Sawyer's Gas Turbine Int.;* **18**: No. 2, 32-35(1977).

During the year 1974 the first Fiat TTG industrial gas turbine equipped with the new fully solid state control system (named FIAT HI-control) entered operation. The control system consists of an analogic section and of a section for the logic processing of on-off signals: the control functions are performed by an analogic governor which prccesses several analogic input parameters and provides an analogic output signal for the positioning of the fuel control valves.

56279 Direct electric gas heating for gas turbines. Abel, G.P. (ELTRON, London, Ltd, Engl). *Sawyer's Gas Turbine Int.;* **18**: No. 2, 36-38(1977).

The advantages offered by electric heating of fuel over the traditional water bath heat exchangers are assessed. In this article, the main emphasis is on gas fuel pre-heating, with brief reference to oil fuel pre-heating and the other problems that can be encountered. Some data on air heating for gas turbines are also included.

56280 Analysis of characteristics of impulse discharge of high-capacity steam turbines. Kuchumova, E.O.; Ekimova, M.M. (Leningrad Polytech Inst im. M.I. Kalinin, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 1, 74-79(1977). (In Russian).

Results of calculations of impulse discharge characteristics of the K-300-240 LMZ condensing turbines and their analysis from the point of view of improving their electromechanical transient processes is presented. The effect of the characteristics of the control systems, the control method, and parameters of control signals, on the depth and length of time of the shedding of the mechanical moment is investigated. Relying on a comparison of impulse diagrams, a recommendation is given to utilize different algorithms of control of emergency discharge of steam turbines during transition from a successive to a separate method of acting on the valves of the high-pressure part and the medium-pressure part.

56281 Analysis of residual stresses/strains in pressure vessels due to cyclic thermomechanical loads. Hsu, T.R. (Univ. of Manitoba, Winnipeg); Too, J.J.M. pp 83-91 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

The analysis of residual stresses and strains induced in pressure vessels by combined thermomechanical cyclic loadings are discussed. Quasi-coupled thermo-elasto-plastic theory, in conjunction with the kinematic hardening rule, was used as the basis for the finite element analysis. Both material and geometric nonlinearities were considered. The versatility and usefulness of this technique was demonstrated by a numerical illustration on a pressure vessel subject to complicated thermomechanical cyclic loads.

56282 Stress analysis of finned-tube water-walls of boilers. Fessler, H.; Stanley, P. (Univ. of Nottingham, Eng.). pp 169-182 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

The effects of tube pressure, furnace pressure and attachment forces acting on plain walls, walls with simple attachment plates or brackets, and corners with brackets have been studied using three-dimensional photoelastic models. In all configurations the tube axes were vertical. The simple horizontal attachment plates extended from crown to crown over three pitches and were integral with the tubewall; they were loaded by horizontal forces normal or parallel to the wall. The bracket attachments consisted of two horizontal plates or ribs integral with the tubewall and extending over five pitches, with the bracket itself fitting between these ribs and joined to them along the edges; the applied loads were horizontal or vertical forces at the bracket, and furnace pressure. Detailed surface stress distributions have been determined. The critical positions were found to be in the fillets at the fin-tube and plate-tube junctions. The application of the model results to the prediction of stresses in boiler walls is discussed.

56283 Design criteria of turbine twisted blading. Troilo, M. (Univ di Genova, Italy). *Termotecnica (Milan);* 30: No. 12, 618-632(Dec 1976). (In Italian).

A rational comparison among the different criteria of twisted blade design can be stated by means of the radial-equilibrium, energy and continuity equations in the simple form. The simplified analysis give a better indication of the behavior of the flow in the different cases, and allows one to perceive which laws of natural behavior of the flow are less conditioned by the selected twisting. In this sense, the work is an extended and deeper review of the classical twisting criteria, available in the literature: free-vortex, constant specific mass flow rate, constant flow angle. As far as the rotor is concerned, laws of twisting based on the pure axial flow and on the constant stage work criteria are considered. Then, the validity of the stated criteria even in the real case, when losses and radial velocity component exist, is briefly discussed. The developed analysis shows some interesting properties of the stages designed with constant specific mass flow rate in the stator and constant work in the rotor. 10 refs.

56284 Calculation of the readiness of power plant equipment. Nechaev, V.V. (Heat and Electr Power Plant, Volga Reg, USSR). *Teploenergetika (Moscow);* No. 12, 17-20(Dec 1976). (In Russian).

A method of calculation of availability indices of a power unit (boiler, turbine, generator) functioning in four principal states: operation, reserve, maintenance, breakdown outage, is presented. An example of practical calculation of availability on the basis of known statistical characteristics of the T-100-130+TVF-120/0 turbogenerator of one of the heat and power plants is presented.

56285 Analysis of the influence of the parameters of a turbine stage with a high d/l ratio on stability of its operation. Troyanovskii, B.M.; Bogomolova, T.V. (Moscow Power Eng Inst, USSR). *Teploenergetika (Moscow);* No. 12, 40-44(Dec 1976). (In Russian).

A theoretical analytical investigation into the effect of the main parameters of a turbine stage with a high D/sub av/l ratio on the inception and ddevelopment of separation zones under operating conditions with diminished volumetric throughput is presented.

56286 Investigation of the turbine separator stage with increased axial gap. Filippov, G.A.; Povarov, O.A.; Nazarov, O.I.; Kalmykov, V.A.; Shuvalov, G.I. (Moscow Power Eng Inst, USSR). *Teploenergetika (Moscow);* No. 12, 45-48(Dec 1976). (In Russian).

Moisture separating capacity of a special turbine separator stage designed by Moscow Institute of Power Engineering is considered and its advantages, as compared with the usual turbine stages, are given.

56287 Investigation of the operation of a T-100-130-type turbine made by the UTMZ plant in steamless regime. Kulichikhin, V.V.; Lyudomirskii, B.N.; Tazhiev, E.I.; Antonov, E.I.; Lesnichenko, A.Ya.; Belyakov, V.M. (Moscow Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 12, 48-51(Dec 1976). (In Russian).

Experimental data are presented on temperature conditions in a T-100-130 turbine, made by the Urals Turbomachinery Plant. The turbine was operating without steam for a long period of time (about 8 hr), without cooling steam being fed into the through part of the turbine. The pressure in the condenser was close to the rated one (0.0037–0.045 MPa).

56288 Thermal tests of a GT-35 gas turbine unit operating in a steam and gas turbine power plant with a high-pressure boiler. Ol'khovskii, G.G.; Povolotskii, L.B.; Kaplan, M.P.; Bumarskov, A.O.; Belov, A.I.; Chernomordik, L.I.; Korzh, P.I. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 12, 51-55(Dec 1976). (In Russian).

Results of thermal tests of a GT-35 prototype gas turbine power plant are presented. Characteristics of the plant and its main elements are determined. Evaluation of the performance of the unit when working independently on natural gas and liquid fuel is carried out.

56289 Permissible value of compensation stresses in piping systems of power plants, operating in creep conditions. Efimenko, G.P.; Osasyuk, V.V. (Inst of Strength of Mater, Acad of Sci of the Ukr SSR). *Teploenergetika (Moscow);* No. 12, 59-61(Dec 1976). (In Russian).

Based on an analysis of the operation of piping systems and taking into account relaxation of compensation stresses and maintenance practice, the conclusion is drawn that it is possible and necessary to increase the permissible compensation stresses, in comparison with the value required by the present Soviet standards, for piping systems of power plants operating in base-load conditions.

56290 Determination of the permissible deflection of boiler headers at steam power plants. Fedoseenko, A.V. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 12, 64-66(Dec 1976). (In Russian).

An approximate relation is derived for the determination of the permissible deflection of headers, caused by creep under the effect of a uniformly distributed load.

56291 Operation of an electromagnetic filter in the scheme of a supercritical pressure power unit. Zubov, I.V.; Kuzmicheva, L.V.; Bogachko, Yu.N.; Alcinikov, G.I.; Belan, F.I.; Glebov, V.P.; Zenkevich, Yu.V.; Sutotskii, G.P.; Kopeliovich, A.M. (Cent Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 12, 66-69(Dec 1976). (In Russian).

Data are presented on the work of an electromagnetic filter with the capacity of 1800 m^3/hr, made by Kraftwerk Union, in the loop of a supercritical pressure boiler.

56292 Improving the reliability of automatic calculation of technical and economic performance indices by the automatic error correction method. Malov, V.V.; Mironov, V.D. (Tulenergo, All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 12, 79-80(Dec 1976). (In Russian).

The character of time-dependent variation of errors of technological parameter measurement channels, having dominant influence on the final errors of automated calculation of performance indices of a power unit, is experimentally established. A method of automatic correction is proposed to reduce the error rate of these channels. It is used under the conditions of a sliding sample signal.

56293 Techniques of vibration analysis applied to gas turbines. Chisholm, R. (Imp Oil Ltd, Calgary, Alberta). *Sawyer's Gas Turbine Int.;* 17: No. 6, 16-22(Nov-Dec 1976).

This paper discusses the results of a two-year program of monitoring the vibration of 30 Solar Saturn and Centaur gas turbines using a real time vibration analyzer. The advantages of a real time analyzer over earlier types of analyzers in troubleshooting units with excessive vibration are discussed. The use of vibration bar charts to evaluate the mechanical condition of a unit is illustrated. An example of a vibration spectrum or signature analysis is given for each section of the turbine-compressor package. Also, techniques of determining the source of vibration are outlined.

56294 Dynamic characteristics of a boiler with combined circulation of a medium. Livshits, M.A.; Dubov, V.N.; Dumnov, V.P.; Bukharov, V.P.; Mikhailov, S.Ya.; Bogomaz, V.I. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 11, 38-41(Nov 1976). (In Russian).

Results are presented of experimental investigations of the dynamic characteristics of a TGMP-324 boiler within 30-100% of the rated load range. They permit evaluation of the effect of recirculation of the medium. The dynamic characteristics are presented in the form of acceleration curves following disturbances of feedwater consumption; synchronous changes in fuel and air consumption; gas consumption for recirculation. Data on the dynamic behavior of the boiler following a disturbance by steam discharge through the steam/steam heat exchanger are also given.

56295 Contamination of heating surfaces of boilers at Tyumen heat and power plant burning local peat. Dunskii, V.D.; Tolchinskii, E.N.; Bulaga, N.A.; Kubseryb, V.I. (Power Eng Inst, B SSR). *Teploenergetika (Moscow);* No. 11, 55-59(Nov 1976). (In Russian).

The processes of contamination (slapping) of radiation heating surfaces and slag removal at Tyumen heat and power plant burning highly slagging peat are analyzed. Measures to ensure reliable operation of boilers are recommended.

56296 Formation of iron oxide deposits in tubes of supercritical pressure boilers. Zenkevih, Yu.V.; Sekretar, V.E. (Cent Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 11, 66-69(Nov 1976). (In Russian).

Tests with addition of three characteristic substances: water-soluble ferriammonium sulfate πNH$sub 4$Fe(SO)$sub 42$^-$, iron hydroxide, and magnetite suspension, are carried out on a PK-30 boiler loop. Experimental results are presented in descriptive and tabular form. It is concluded that the values of coefficients of deposition of iron compounds depend, to a considerable extent, on the state of these compounds in water. The most radical way to extend the period between cleanings if reduction of the concentration of iron compounds in feedwater. This can also be attained by using new feedwater treatment methods based on the formation of soluble compounds, such as treatment with complexing agents, addition of hydrogen peroxide or oxygen, or combined promising methods.

56297 Erroneousness of adding hydrogen peroxide into boiler unit tract with brass low-pressure heaters. Zubov, I.V.; Kuz'micheva, L.V.; Margulova, T.Kh. (GRES, Kostroma, USSR). *Teploenergetika (Moscow);* No. 11, 69-71(Nov 1976). (In Russian).

Results of an experimental investigation of the conditions of dosage of hydrogen peroxide to the condensate of a 300 MW boiler unit at the Kostroma District Power Station are presented. It is shown that continuous dosage of hydrogen peroxide into the condensate of boiler units with low-pressure heaters made of brass coils must not be permitted.

56298 Problem of formation of salt deposits and their effect on physical processes in flow-through parts of turbines. Zolotareva, V.A. (B SSR Polytech Inst). *Izv. Vyssh. Uchebn. Zaved., Energ.;* 57-64(Nov 1976). (In Russian).

The process of formation of deposits, depending on different surface roughness of the turbine blading ring, in conditions of a power plant, is investigated on an industrial and a laboratory setup. The effect of deposits as a whole and of their individual components on energy losses and structure of flow turbulence in the blading ring is also investigated. These studies permit clarification of a number of physical regularities of deposition of salts and metal oxides in flow-through parts of turbines.

56299 Selection of a rational program of control of high pressure condensing steam turbine power plants. Ivanov, V.A.; Leonkov, A.M.; Borovkov, V.M.; Berkovich, Ya.D. (Leningrad Polytech Inst im. M. I. Kalinin, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* 133-136(Nov 1976). (In Russian).

The possibility of changeover of steam turbines, installed at condensing electric power plants with steam cross connections for the pressure of 90 kgf/cm^2, to a sliding pressure, to increase thermal efficiency, is considered. Likewise, the possibility of switching over the high pressure heater, the last in the feedwater line, to the chamber of the regulating stage, when it reaches a pressure that is equal to the pressure of steam in the switched-over high pressure heater at the rated operating conditions is indicated.

56300 Investigation of the axial force in the turbine section with a bleeding chamber. D'yakonov, R.I.; Drokonov, A.M.; Sivaev, V.M. (Bryansk Inst of Transp Mach, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* 136-140(Nov 1976). (In Russian).

Experimental data about the effect of steam bleeding on the axial force in the superposed stage of the bleeding chamber of a steam turbine are given.

56301 Heat transfer during steam condensation on tube bundles of alternating slope and different directions of flow supply. Buglaev, V.T.; Andreev, M.M.; Kleshchevnikov, V.P. (Bryansk Inst of Transp Mach, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* 140-144(Nov 1976).

Results of an analysis and generalization of experimental data are presented regarding investigation into the heat transfer process during the condensation of steam from a flowing steam-and-air mixture upon a corridor-type tube bundle with alternating angles of inclination of the latter to the horizontal plane and different directions of steam-and-air flow supply.

56302 Evaluation of service life of steam turbine casings in thermal fatigue conditions. Trukhnii, A.D.; Martynov, Yu.D.; Bystritskii, D.B. (Moscow Energet Inst, USSR). *Teploenergetika (Moscow);* No. 10, 25-28(Oct 1976). (In Russian).

Results are presented of an experimental investigation into low-cycle fatigue and short-time creep of cast steels 25L, 20CrMoVL, and 15Cr1Mo1VL.

56303 Warming-up of frames of double-walled medium-pressure cylinder of a K-300-240 turbine made by Kharkov Turbine Works. Prokopenko, A.G.; Stasyuk, N.P.; Tkachuk, N.V.; Shcherbina, A.V. (ORGRES, USSR). *Teploenergetika (Moscow);* No. 10, 28-30(Oct 1976). (In Russian).

Results of investigations of temperature fields of frames of the two-walled medium-pressure cylinder of the turbine in question, with start-up from different thermal conditions, are presented.

56304 Results of natural-size investigations of variable conditions of operation of the low pressure section of a district heating turbine. Shapiro, G.A.; Lagun, V.P.; Simoyu, L.L.; Efros, E.I.; Zakharov, Yu.V. (Kirovsk Polytech Inst, USSR). *Teploenergetika (Moscow);* No. 10, 31-34(Oct 1976). (In Russian).

An analysis is presented and the causes of variations in the efficiency of the low-pressure section (LPS) and its individual stages within a wide range of operating conditions of the turbine, with a fully and partially open revolving diaphragm, are considered. The possibility of generating the experimental data obtained by relations of the type of a universal capacity correction curve regarding vacuum changes in the condenser is demonstrated.

56305 Investigation of a stage with a small d/sub av$/l/sub blade/ ratio and lowered radial gradient of the degree of reactivity. Shnee, Ya.I.; Garkusha, A.V.; Shvedova, T.I. (Khar'kov Polytech Inst, Ukr SSR). *Teploenergetika (Moscow);* No. 10, 34-40(Oct 1976). (In Russian).

The effect of the angle of inclination of the outer circumference of the stator and of the overlap between blades for stages with the so-called direct and reverse twist of nozzle blades is investigated.

56306 Combined method of cleaning boiler heating surfaces. Ots, A.A.; Suurkuusk, T.N. (Tallin Polytech Inst, Est SSR). *Teploenergetika (Moscow);* No. 10, 60-64(Oct 1976). (In Russian).

Based on up-to-date ideas about contamination and wear of heating surfaces in boilers operating on fuels with a complex content of inorganic substances, a new combined cleaning method is considered. In order to clean the highly contaminated waterwall heating surfaces from ash deposits, it is recommended to apply vibration cleaning (2 to 4 times per shift) in combination with thermocyclic water-jet cleaning.

56307 Improvement of cleaning of boiler heating surfaces by steam blowing devices. Dubovskii, I.E.; Peselev, M.P. (Cent Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 10, 64-68(Oct 1976). (In Russian).

Results are presented of an investigation of nozzle arrangements of steam blowing devices using superheated steam. Recommendations are given on the selection of the parameters of operation of steam blowing devices taking into account prevention of wear of the heating surfaces in the course of purging.

56308 Pressure loss coefficient of impingement cooled leading edge system of a turbine blade. Mukherjee, D.K. (Brown Boveri and Co, Baden, Switz). *J. Eng. Power;* **98**: No. 4, 554-556(Oct 1976).

The pressure loss coefficient of an impingement cooled system similar to that often used to cool the leading edge of a turbine blade has been determined from model test. The influence of Reynolds number in the range tested is negligible. However, the influence of relative distance of the jet holes from the surface to be cooled is very significant.

56309 Computer-aided investigation of dc generators. Kopylov, I.P.; Artem'ev, V.A.; Kiselev, V.I. (Moscow Energet Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 10, 43-48(Oct 1976). (In Russian).

An effective method of investigation and optimization of dc generators relying on an analog model and application of the experiment planning method with the aid of a computer is presented.

56310 Development of steam generator construction at the Taganrog Krasnyy Kotelshchik plant in the tenth five-year plan period. Parshin, A.A.; Khristich, L.M. *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 10, 56-60(Oct 1976). (In Russian).

The majority of large steam power plants under construction in the USSR in the 1976--1980 period will be equipped with supercritical pressure steam generators for 300--1200 MW power units, made at the Taganrog Plant. Some features of the new steam generators are described.

56311 Film cooling with injection through slots. Mukherjee, D.K. (Brown, Boveri and Co, Baden, Switz). *J. Eng. Power;* **98**: No. 4, 556-559(Oct 1976).

The work deals with film cooling of a surface with injection through slots. From the vast number of literatures surveyed, the

cooling effectiveness for an ideal geometry--a flat plate with no pressure gradient having tangential blowing from a slot with no lip thickness--could be found by using a suitable blowing parameter for three different regions. The influence of blowing angle and lip geometry has been investigated and defined.

56312 Comparative tests of a TP-100 boiler with closed-loop and open-loop systems of p.f. preparation when burning Lvov-Volynian pit coal. Kapel'son, L.M.; Anokhin, V.M. (ORGRES, USSR). *Teploenergetika (Moscow);* No. 9, 39-43(Sep 1976). (In Russian).

In the last few years open-loop system of p.f. preparation have been introduced at several power plants with high-capacity boilers. It was thought that the discharge of the drying agent from p.f. systems, bypassing the steam generator into gas ducts after the heating surfaces, would increase the efficiency of the boiler by reducing heat losses with flue gases and improving fuel combustion efficiency. Results of tests on a TP-100 boiler of a 200 MW power unit carried out prior to and after the opening of the p.f. systems did not show in any noticeable change in the temperature level in the combustion chamber and boiler efficiency.

56313 Rational ways of increasing unit capacity of power gas turbine installations constructed according to a simple thermal diagram. Tyryshkin, V.G.; Makarov, V.N.; Sheinzon, E.M.; Bodrov, I.S.; Reznichenko, V.Ya. *Energomashinostroenie;* No. 8, 19-21(1976). (In Russian).

A relation is established among the main parameters of the cycle of a gas turbine installation made according to a simple thermal diagram. The parameters in question determine its unit capacity. Rational methods to increase this capacity are considered. Among them is the use of a new axial compressor based on KND GT-100-750 which will permit an increase of the capacity of a proposed 100-115 MW gas turbine power plant to 140-150 MW. Aerodynamic improvement of the blading and use of higher initial temperatures (up to 1200°C) will permit its capacity to be increased to 170-180 MW.

56314 Use of holography in power engineering. Bavel'skii, D.M.; Listovets, V.S.; Ostrovskii, Yu.I.; Sidorenko, V.F.; Trofimovskii, V.V.; Chubarov, V.A.; Etinberg, M.I. *Energomashinostroenie;* No. 8, 21-24(1976). (In Russian).

Methods of holographic interferometry adopted for quality control of components in power engineering are reviewed. Results of practical implementation of these methods on experimental setups in factory conditions are presented. 9 refs.

56315 Industrial tests of a membrane economizer on a TP-120 boiler at the Saratov No.2 heat-and-power plant. Lokshin, V.A.; Levchenko, G.I.; Kopeliovich, A.M.; Zmachinskii, A.V.; Akimov, Yu.A.; Liseikin, I.D.; Protsenko, A.D.; Medvedev, V.A.; Suntsov, A.N. *Energomashinostroenie;* No. 9, 1-3(1976). (In Russian).

Test results obtained on a natural gas and fuel oil-fired boiler are presented. Data on thermal and aerodynamic characteristics as well as on the temperature conditions are obtained. Reliability of the operation of the novel membrane surface is noted and its wider use in industrial models of steam generators is urged.

56316 Selection of the reasonable standard size and profile of power blocks for central Siberian conditions. Mitor, V.V.; Moiseeva, L.N.; Apatovskii, L.E.; Mochan, S.I.; Frenkel, L.D.; Golovanov, N.V.; Matorina, B.E.; Sekretar, V.P. *Energomashinostroenie;* No. 9, 16-18(1976). (In Russian).

The main problems of designing extra large power units burning Kansk-Achinsk coal grades are given. The main difficulty is the instability of the composition of coal grades from different deposits and very unfavorable properties of their ash which contains large quantities of alkali-earth metal oxides. It is concluded that the most suitable standard size of a large power unit for Central Siberia (after 700 MW blocks) is a power block with unit capacity of 1MW.

56317 Use of computers for aerodynamic calculations in designing a turbine stage with long blades. Zhukovakii, G.V.; Dolgoplosk, E.B. *Energomashinostroenie;* No. 9, 32-34(1976). (In Russian).

A method of designing a turbine stage is set forth, in which a computer is used for aerodynamic calculations. Tests on an experimental turbine show that the efficiency of the stage thus designed attains 90.5%, i.e., it is considerably higher than the efficiency of a stage designed according to the conventional methods.

56318 Effect of the throughput capacity of nozzle cascades on the economic efficiency and reliability of a turbine installation. Arkad'ev, B.A.; Pyasik, D.N.; Bratuta, E.G.; Shatilov, S.P. *Energomashinostroenie;* No. 9, 4-6(1976). (In Russian).

The dependence between the changes in the flowrate coefficient of the nozzle apparatus and the efficiency of the stage is derived. The effect of a deviation of the throughput capacity of the direct-flow part of the turbine from its rated value on the value of the thermal efficiency of the cycle and thrust pressure is established.

56319 Characteristics of a control disk throttle with a limited angle of swivel. Popov, E.F.; Pshenichnyi, V.D.; Gitel'man, A.I. *Energomashinostroenie;* No. 9, 14-16(1976). (In Russian).

The possibility of ensuring linear variation in flowrate characteristics of a control disk throttle by limiting its angle of swivel is demonstrated. The effect of this limitation on the torque characteristic of the throttle and static pressure losses is considered.

56320 Synthesis of optimal design of variable-section rotor blades. Shubenko-Shubin, L.A.; Stoyanov, F.A.; Rogovoi, M.I. *Energomashinostroenie;* No. 9, 22-24(1976). (In Russian).

A method of designing variable-section rotor blades with minimal flow-past energy losses, while meeting strength and reliability requirements, is proposed.

56321 Gas and fuel oil boiler unit for an 800 mW power block. Parshin, A.A.; Shchukin, E.M.; Reznik, V.I.; Khristich, L.M.; Reznik, N.I.; Gol'denfarg, I.N.; Sivtsov, A.I.; Skryl', V.M. *Energomashinostroenie;* No. 10, 1-5(1976). (In Russian).

Design features of the new TGMP-204 boiler unit with the capacity of 2650 t/hr for gas and oil fuel firing with supercharging are described. Its main design principles are presented and some problems of construction of this boiler unit are considered. The design, structural and comparative technical and economic data with regard to this boiler are given.

56322 Fundamental principles of algorithmization and programming of integrated computer-aided boiler unit design. Tyntarev, E.M.; Mochan, S.I. *Energomashinostroenie;* No. 10, 5-7(1976). (In Russian).

The necessity of developing a program of integrated computer-aided design of boiler units, comprising thermal, hydraulic, thermomechanical etc. designs, including determination of mass and cost characteristics, is shown and the main principles of working out such an algorithm and program are given.

56323 Investigation of circulation and separation characteristics of a low-capacity high pressure boiler with external cyclone. Musaelyan, A.G.; Somov, V.V. *Energomashinostroenie;* No. 10, 8-9(1976). (In Russian).

A low-capacity high pressure boiler with external cyclone, designed on the basis of a system of gas turbine supercharging with a reversible pneumatic machine and with utilization of a unit for burning gaseous and liquid fuel, is described. Unlike other designs of high-pressure boilers with external cyclones and forced circulation, this boiler has natural circulation of water. Results of tests of water circulation and steam separation in the evaporation circuit are presented.

56324 Improving the efficiency of low-capacity gas turbine engines. Landa, G.R.; Zaritskii, S.P.; Reshed'ko, S.D.; Amlas, A.M.; Kaminskii, L.V.; Burmistrov, A.I.; Morovskii, A.V. *Energomashinostroenie;* No. 10, 9-11(1976). (In Russian).

A comparative analysis of gas turbine engines designed according to the scheme comprising a gas power turbine after a turbocompressor, and according to the scheme with a free air turbine after the impeller of the compressor, is presented. It is shown that designing the centrifugal compressor according to the above loop scheme permits a reduction in the mass and size of the engine while maintaining satisfactory efficiency and relatively low manufacturing costs.

56325 Calculation and analysis of steady-state regimes of low pressure cylinders of steam turbines. Usachev, I.P.; Neutmin, V.M.; Tikhomirov, A.N. *Energomashinostroenie;* No. 10, 11-13(1976). (In Russian).

Exact calculation of ventilation losses in low-pressure cylinder stages of high-capacity steam turbines is carried out. The dominant influence of the ventilation effect on the level of capacity losses is shown. A formula is obtained for the calculation of capacity losses to ventilation. It is characterized by the functions of the axial width of the rotor blade profile and of the density of the steam medium.

56326 Experimental investigation of the effect of frequency nonuniformity on the level of resonance vibrations of rotor blades. Nabatova, N.A.; Shipov, R.A. *Energomashinostroenie;* No. 10, 14-16(1976). (In Russian).

Data of measurements of the amplitudes of resonance vibrations of three variants of the rotor of an axial compressor are presented. These variants differ by the frequency composition of the blades. It is shown that the overall frequency difference has but a weak effect on the scatter and level of maximum vibration amplitudes of blades. Some effect of a sharp frequency drop-out on the amplitude level is noted.

56327 Quasithreedimensional calculation of flow in turbine stages. Dorfman, L.A.; Serazetdinov, A.Z.; Levina, S.R.; Evgen'ev, V.Yu. *Energomashinostroenie;* No. 10, 16-18(1976). (In Russian).

A method of calculation of the three-dimensional subsonic flow in turbomachines is given. It is based on a successive refinement of averaged inter-blade surfaces and axisymmetrical flow surfaces in

combination with the necessary geometric constructions and considerations of viscous effects. The calculation is realized in the automatic mode of computer operation.

56328 Effect of rotor inlet conditions on the head characteristic of a condensate pump state. Yalovoi, N.S. *Energomashinostroenie;* No. 10, 18-20(1976). (In Russian).

Experimental data are presented which evaluate the effect of the characteristics of inlet pipe connections, inlet stators and axial superposed rotors on the form of the head characteristic of the first stage of a condensate pump.

56329 Setting up vibration reliability testing systems for parts and units of power plant equipment. Bozhko, A.E. *Energomashinostroenie;* No. 10, 30-31(1976). (In Russian).

Structural diagrams of systems for vibration testing of components and units on resonance frequencies are presented. A system for level and phase stabilization of the vibration testing conditions, as well as a self-generating system, are considered. The superiority of vibration regime phase stabilization systems is demonstrated.

56330 Investigation of the structural strength of welded and forged turbogenerator rotors. Vasil'chenko, G.S.; Chernykh, V.V.; Koshelev, P.F.; Kolpishon, E.Yu.; Rybovalov, Yu.P. *Energomashinostroenie;* No. 10, 31-34(1976). (In Russian).

Results of investigations of the structural strength of electric slag welds of the 25CrNi3MoV (high grade) steel as used in turbogenerator rotors are given.

56331 Calculation of the motion of a medium in schematized elements of turbine ducts. Morozov, D.I. *Energomashinostroenie;* No. 10, 41-42(1976). (In Russian).

Results of an exemplary calculation of three-dimensional vortex-free flow in the schematized diffuser of a steam turbine are presented. It is found that flow asymmetry and swirl decrease sharply towards the inlet to the diffuser. A recommendation regarding its length is given.

56332 Boosting of power gas turbine installations by water injection into the high pressure tract. Kirillov, I.I.; Arsen'ev, L.V.; Kotov, Yu.V.; Bodrov, I.S.; Berkovich, A.L. *Energomashinostroenie;* No. 12, 1-4(1976). (In Russian).

The efficacy of application of water injection into the high pressure tract of power gas turbine installations of different type is considered. It is shown that injection of each percentage point of water into the tract of a high-temperature gas turbine installation, designed according to a single thermal diagram, increases the capacity by about 4% and can be utilized to improve the dynamic properties of power plants.

56333 Method of measurement for thermal tests of the GT-100-750-2 LMZ (Leningrad Metal Works) gas turbine power plant. Ol'khovskii, G.G.; Bodrov, I.S.; Mekhanikov, A.I.; Vasil'ev, A.A.; Antonov, O.N. *Energomashinostroenie;* No. 12, 12-15(1976). (In Russian).

Data are given on the elaboration of a measurement scheme for thermal tests of the indicated gas turbine installation. Results of test-bed calibration and of tests of special measuring devices are given. Specific features of assembly and adjustment of these devices, as well as the measurement schemes, are considered.

56334 Selection of thermal diagram of intermediate superheaters of gas and oil fuel-fired boilers. Reznik, V.I.; Shleifer, B.M.; Zaraiskii, S.I.; Shchukin, E.M.; Konashev, S.L.; Skryl', V.M. *Energomashinostroenie;* No. 11, 1-4(1976). (In Russian).

Designs of intermediate superheaters of the conventional and gas-tight boilers for 300 MW power units are compared from the point of view of their technico-economic performance indices and design features. Recommendations are given on designing diagrams of intermediate superheaters for high-capacity boilers.

56335 Investigation of surge protection of compressors of gas turbine power plants. Borovkov, A.I.; Zil'berman, B.I. *Energomashinostroenie;* No. 11, 6-8(1976). (In Russian).

Using the method of small deviations, the relation between the surge prevention valves and the displacement of the working point on the universal characteristic curve of the compressor, following a change in the temperature of the outside air, is investigated for a number of typical schemes of gas turbine plants.

56336 Some aspects of the problem of control of Kaluga Turbine Plant turbines with generators of a new series. Blagoveshchenkii, V.V.; Lukashevich, V.E. *Energomashinostroenie;* No. 11, 8-10(1976). (In Russian).

Results are presented of an investigation of some problems of control of the frequency of revolution of KTZ (Kaluga Turbine Plant) steam turbines, as well as the measures taken by the KTZ Plant in connection with transition to generators of a new series.

56337 Evaluation of concentration of stresses in creep conditions with nonsimple loading. Ugorskii, A.E. *Energomashinostroenie;* No. 10, 22-23(1976). (In Russian).

An approximate method of investigation of stress concentration in conditions of nonsteady creep under the effect of nonsimple loading is considered within the framework of the theory of aging. Examples are shown where the relations thus established can be utilized.

56338 Investigation of gas turbine plant control systems with two controllers acting on one actuator. Dzhigit, G.A.; Krushel'nitskii, N.Z.; Marchevskii, V.P.; Sarantsev, K.B. *Energomashinostroenie;* No. 11, 12-15(1976). (In Russian).

Problems of stability of control systems of gas turbine plants with two controllers--of low-pressure shaft speed and of gas temperature before high-pressure turbine--are considered. Appropriate transient processes are obtained, a method of determination of static characteristics of the nonlinear system is given, and the static control error is determined.

56339 Automation of drawing and graphic work in turbine construction. Palagin, A.A.; Lykhvar, N.V. *Energomashinostroenie;* No. 11, 16-17(1976). (In Russian).

An example of automation of drawing and graphic work in the course of designing rotor blades, which are one of the most mass-produced elements of steam turbines, is presented. A mathematical description and a system of programs for the computer-aided design of blades is given.

56340 Effect of rigidity and damping of bearings on the value of threshold capacity of self-exciting vibrations of steam turbine rotors. Berlyand, V.I.; Markovskii, I.A. *Energomashinostroenie;* No. 11, 37-39(1976). (In Russian).

Results of a theoretical investigation of the dependence of the threshold capacity of self-exciting vibrations of turbine rotors on the level and anisotropy of rigidity and damping of bearings are presented. Calculations are made for a reduced single-disk two-bearing rotor on elastic damper bearings. It is shown that there exist optimal values of rigidity and damping of bearings to which the threshold capacity maximum corresponds.

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 56251, 56981, 56987, 57006, 57007, 57008, 57022

56341 Methods for conveying and utilization of waste heat from power plants. Alefeld, G. (Tech Univ, Munich, Ger.). *Brennst.-Waerme-Kraft;* **29**: No. 3, 94-98(Mar 1977). (In German).

The article considers the use of high-pressure gas, such as ammonia or propane, as a media for cooling of power plant condensers, which is then fed into pipelines to consumers for heat recovery. The same gas would be returned as a liquid to the power plant. This system makes it possible to lower the condenser temperature to 30 to 25°C, resulting in an improved efficiency of the power station of 36 to 39%, compared to the cooling tower operation at 33%.

56342 Technical development of district heating in the German Democratic Republic. Peer, V.A. (Dtsch BP, Hamburg, Ger.). *Fernwaerme Int.;* **6**: No. 1, 7-9(Mar 1977). (In German).

The history of the development of district heating in the GDR is closely related to that in Germany--the first important heat-electric station with an output of 24.5 Gcal/h was built in Dresden in 1898. Today district heating in Dresden has an output of over 500 Gcal/h. At the moment about 785,000 dwellings are supplied with district heating in the GDR. The connected heating load was estimated in 1975 to be 6,600 Gcal/h. The output of district heating is to be raised to about 11,800 Gcal/h in 1980 and to about 22,000 Gcal/h in 1990. For the future development of district heating supply the standard Type TR 50/60 turbines are to be used, which should give a reduction of investment costs.

ECONOMICS

REFER ALSO TO CITATION(S) 56236, 56591, 56592, 56979

OFF-PEAK ENERGY STORAGE

REFER ALSO TO CITATION(S) 56884

56343 Storage of steam in off-peak periods for application during peak demands. Bitterlich, E. (Dtsch Babcock, Oberhausen, Ger). *Brennst.-Waerme-Kraft;* **29**: No. 2, 51-58(Feb 1977). (In German).

The article shows that integrating a hot water accumulator into a modern power station provides a solution to the peak-load problem, as well as for district heating, which is sensible both from the national economy as well as from the engineering side. It deals in particular with storage systems for balancing load fluctuations in the

electricity demand, the need for peak-load power stations in the Federal Republic of Germany, also showing what limits the specific cost of power production, the specific heat consumption, and the installation cost of the storage system may not exceed.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 56243, 57362, 57363, 57378, 57401, 57405, 57443

56344 (NP—22244(Vol.1)) **Environmental impact analysis of Coyote Station. Volume 1.** (Stearns-Roger Corp., Denver, Colo. (USA)). Aug 1976. vp. Inc., Denver, CO.

Coyote Station is a proposed 440 MW coal-fired power plant to be located near Beulah, N.D. which will supply electric power in North Dakota. Sufficient engineering and environmental studies have been completed to begin applying for the federal and state permits necessary to begin construction. This environmental impact analysis is derived from those studies and contains information on project design and location; existing environment; impact of proposed project; favorable and unavoidable adverse effects; and alternatives to proposed project. (LCL)

THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 56239, 56752, 57386

56345 Evaluation of alternative dry/wet cooling concepts for power stations. Allemann, R.T.; Johnson, B.M.; Faletti, D.W.; Smith, G.C.; Tokarz, R.D.; Walter, R.A. (Battelle Pacific Northwest Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* **26**: 115-116(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 56265, 57364

56346 (PB—264891) **Report of the Hearing Panel: National Public Hearing on Power Plant Compliance with Sulfur Oxide Air Pollution Regulations, conducted October 18, 1973 through November 2, 1973.** (Environmental Protection Agency, Washington, D.C. (USA). Office of the Administrator). Jan 1974. 108p. NTIS PC A06/MF A01.

The following topics are discussed: summary and recommendations; background; utility compliance efforts; status of flue gas desulfurization technology--lime/limestone FGD technology, Wellman-Lord sodium-based scrubbing, technology summary; vendor guarantees; flue gas desulfurization system malfunctions; waste disposal; costs of flue gas desulfurization systems; time requirements for installation of flue gas desulfurization systems; and capacity of vendors to install flue gas desulfurization systems.

56347 Exhaust gas emissions of Brown Boveri gas turbines. Koch, H.; Felix, P. *Brown Boveri Rev.;* **64**: No. 1, 27-33(Jan 1977).

During the combustion process in gas turbine plants so-called pollutants are formed, consisting of substances resulting from incomplete combustion as well as oxides of nitrogen and sulphur. Since in the combustion chamber, these pollutants behave differently, sometimes even oppose each other, an effective reduction of these pollutants presupposes an appropriate conception of the combustion chamber. To be able to meet existing emission rules, additional measures are required, however, for the reduction of the NO$sub x$ content. Calculations as well as measurements show, as a whole, favourable emission results for the Brown Boveri gas turbines and thus confirm the correctness of the Brown Boveri combustion chamber conception.

56348 Ways to reduce atmospheric pollution in cities by fuel combustion products. Styrikovich, M.A.; Minaev, E.V.; Troitskii, A.A.; Vnukov, A.K. *Teploenergetika (Moscow);* No. 9, 26-32(Sep 1976). (In Russian).

Air pollution in a typical city with over 1 million inhabitants and with varied industry is considered. An attempt is made to evaluate experimentally the share of participation of all the types of sources of pollution in overall pollution. Taking the city as a whole, the quantities of CO, SO_2, and NO_x discharged into the atmosphere are in the ratio of 0.88; 1.00; 0.65. At the breathing level this ratio is, however, 94:1:1. The share of transportation exhaust gases in air pollution is respectively, CO--65%, NO--48% and SO_2--12%. It is found that the share of power plants is disproportionately far below the amount of pollutants that they discharge into the atmosphere. This is due to the height at which they discharge the pollutants.

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 56089, 56231, 56389

56349 (EPRI-EL—453(6-77)) **Current limiting fuse study. Final report.** Hudis, M.; Bhargava, B.; Wycklendt, D.A. (Allis-Chalmers Corp., Milwaukee, Wis. (USA)). Jun 1977. 60p. Dep. NTIS, PC A04/MF A01.

A study of current limiting fuses aimed to improve performance with corresponding higher current ratings in a single barrel is presented. The overall program was directed towards new element design, gas impregnation, and composite polymer sand fillers. The new element design is based on a freestanding cylinder approach with a large surface area-to-volume ratio. The new element design provides better heat transfer and higher arcing gradients. New filler mixtures also increase arcing gradients and improve interruption capability. Better heat transfer, higher arcing gradients and improved interruption capability will improve overall performance of the fuse and increase the current rating. The full-size experiments (15 kV, 200 A) demonstrated significant improvements in the average arc voltage and rating capability when compared to existing state of the art technology. The information, ideas, and technical data disclosed do not necessarily represent practicable or thoroughly tested devices and should not be used as the basis for manufacture or construction without further investigation as to safety and suitability. The experiments also revealed some critical problem areas which must be addressed before significant fuse progress can be made available to the utility market.

56350 Process computer in electric substations. Heumesser, G. *Elin-Z.;* **29**: No. 1-2, 32-39(1977). (In German).

The use of process control in power distribution plants leads toward the installation of freely programmable computers in substations. The resulting pros and cons of the operation and malfunction analysis of this system are listed. Resolutions outlined are considered an alternative to the conventional remote control technique.

56351 Various methods of studying the reliability of power systems. Koenne, W.; Pressler, J.; Zinterhof, P. (Oesterr Elektrizitaetswirtsch, Vienna). *Oesterr. Z. Elektrizitaetswirtsch.;* **29**: No. 12, 513-524(Dec 1976). (In German).

Methods of computing the outage risk of large systems are reported. The combination model is based on the theory of probabilities, starting out from individual outage situations on a system. A continuation of this model, which involves shorter computing times, is the convolution model . In the Gauss model , an attempt is made to use the concept GUETE (quality) for defining a quantity to be used for comparing power systems. An entirely different method of treating a system by the means of information theory, with the help of the concept of entropy, is outlined in an annex.

56352 computational experiment in the investigation of electromagnetic transient processes in electric power transmission lines. Novash, V.I.; Strelyuk, M.I.; Svita, L.N. (B SSR Polytech Inst). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 10, 8-13(Oct 1976). (In Russian).

The possibility of calculation of electromagnetic transient processes in long-distance three-phase lines, relying on a T-chain equivalent circuit of electric lines, by a numerical method, is considered. A method of calculation of transient processes in electric power lines with different types of breakdown (symmetrical and asymmetrical short-circuits) according to set regime parameters at the end of the line is proposed. An algorithm and a program of calculation of transient processes of electric power transmission on a digital computer taking into account phase transposition and the effect of the closeness to the ground are compiled.

56353 Rekatic, a control and monitoring system for transformer stations. Gebelein, H.; Otto, P. *AEG-Telefunken Prog.;* No. 2, 55-57(1976).

Rekatic is a new shop-assembled control and monitoring system in relay card technique for switching stations in electric power supply systems. Functions --such as local and remote control, remote position indication, interlocking, transformer ratio control and synchronization --are grouped into individual modules. The design of the Rekatic system for high security against interference voltages makes additional coupling relays superfluous and its employment also in 420 kV switching stations possible. The wiring technique of the Rekatic system conforms with the latest state of the art.

56354 Remote terminal units. Lundqvist, C.G.; Malmqvist, L.G. *ASEA (Allm. Sven. Elektr. A. B.) J.;* **49**: No. 5, 111-114(1976).

ASEA's new remote terminal units built up from components in the DS-8 digital electronic system are presented. Such units are included in remote supervisory control systems for power and industrial installations. They provide better monitoring and operational ability.

AC SYSTEMS, EHV AND UHV

56355 (CONS/2066—1) **Report of feasibility of high phase order transmission.** Stewart, J.R.; Wilson, D.D. (Power Technologies, Inc., Schenectady, N.Y. (USA)). Feb 1977. Contract EX-76-C-01-2066. 112p. Dep. NTIS, PC A06/MF A01.

The general feasibility of high phase order (HPO), e.g., 6-phase, power transmission was studied and confirmed. The attendant potential for significant increases in power density efficiencies of rights-of-way is discussed. It is recommended that the next phase in the development of this technology is one of tests and experiments to verify and extend analytical results and define the mechanical characteristics of actual HPO structures and conductor arrays. This includes experimental verification of electric field intensities, corona performance, radio interference, audible noise, television interference, and investigation of the electrical breakdown of closely spaced conductors during impulse. Of primary importance is investigation of mechanical characteristics of HPO structures, insulators, and conductors during motions due to wind, ice conditions, and fault currents. The mechanical aspects are particularly important as HPO arrays may have conductors suspended from, and insulated from, other conductors at different potentials. These investigations will establish the data necessary for preliminary line designs and allow accurate economic studies of HPO variations and comparison with 3-phase (or other) alternatives.

56356 (EEI-RP—90-2) **Investigation of hybrid systems for power systems analysis. The ac/hybrid power system simulator. Final report.** Michaels, L. (Electronic Associates, Inc., West Long Branch, N.J. (USA)). 1 Nov 1970. vp. Electric Inst., New York, NY.

The results of an investigation into the use of hybrid computer systems for the solution of problems associated with the generation and transmission of electrical power are summarized. An eighteen-month study was conducted at EAI's Princeton Computation Center to determine if hybrid computing techniues could result in the capability of real time, or faster, transient stability studies. It was determined that a special purpose hybrid system could provide simulations of power system transient disturbances 100 times faster than real time. A working model of the proposed ac/hybrid power system simulator was built which consisted of 5 generators, 15 lines and 12 buses. Tests on this prototype have proven successful, and indicate that 100 times real time transient stability studies can be obtained regardless of the size of the system under study. The proposed simulator could be used for on-line operator advisory functions, optimization of system operating conditions to maximixe security, or eventually for on-line automatic control of electromechanical transients.

56357 (NP—22244(Vol.2)) **Environmental impact analysis of Coyote Station. Volume 2.** (Stearns-Roger Corp., Denver, Colo. (USA)). Aug 1976. vp. Inc., Denver, CO.

The engineering details and environmental studies for a proposed 345 kV power transmission system which will connect electric power generated at the proposed 440 MW coal-fueled Coyote Station at Beulah, N.D. with existing 115 kV transmission systems are discussed. (LCL)

56358 Investigations related to the calculation of steady-state conditions of electric systems comprising long ac and dc electric power lines. Arutyunyan, S.G. (Erevan Polytech Inst im. K. Marksa, Arm SSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* 9-15(Nov 1976). (In Russian).

A method of jointly solving equations of steady-state conditions of an ac network of a complex structure and complete equations of compensated aerial lines and dc transmissions is presented. An improved convergence of iteration according to Seidel's principle in the proposed method is ensured, on the one hand, by calculation of conditions of operation of the singled-out ac and dc transmissions according to certain schemes that eliminate the necessity of using the method of successive approximations, and, on the other hand, by representing adjacent power system by equivalent multipoles.

56359 Design, application and testing of SF_6 insulated cable. Eidinger, A. *Brown Boveri Rev.;* **63**: No. 11, 688-394(Nov 1976).

For rated voltages above about 245 kV the high current-carrying capacity of SF_6 compressed gas insulated cables enable the range of application of underground power transmission systems to be considerably extended. Normally SF_6 insulated cables are provided for rated currents between 1500 and 3000 A; if necessary, and with a correspondingly adapted design, much higher values are attainable. The article discusses series and parallel operation of lines and cables, possible applications of gas-insulated cables, development and dimensioning of gas-insulated cable, and testing of all components of a compressed gas hv system in a trial run.

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

56360 (CONS/3800—1) **Helium research in support of superconducting power transmission. Annual report, July 1975—September 1976.** Jones, M.C.; Arp, V.D.; Parrish, W.R.; Daney, D.E.; Ludke, P.R.; Frederick, N.V.; Hands, B.A. (National Bureau of Standards, Boulder, Colo. (USA). Cryogenics Div.). Feb 1977. Contract EX-76-A-10-3800. 90p. Dep. NTIS, PC A05/MF A01.

This is the second annual report of research on helium related problems in support of superconducting power transmission development. Results are presented from experimental and computer modeling of the performance of current leads cooled with supercritical helium gas. Performance characteristics studied are burn-out conditions and existence of oscillation in the helium gas. Some conclusions on the feasibility of data transmission from high-voltage regions to grounded read-out instrumentation, on thermometry and on helium impurity measurements are reported. Test results of microwave cavity pressure transducers for use at helium temperatures are discussed in detail. Some improvements in computer codes for helium properties and some recent data on the thermal conductivity of helium are described. A recently completed flow facility is described which has been built for research on flow and heat transfer dynamics of supercritical helium in channels of high aspect ratio modeling superconducting power transmission line channels.

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 56094, 56155, 56666, 56939

56361 (CONF-770441—2) **Siting studies for an asymptotic U.S. energy supply system based primarily on nuclear energy.** Burwell, C.C. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26;EY-76-C-05-0033. 36p. Dep. NTIS, PC A03/MF A01.

From American Nuclear Society executive seminar on nuclear energy centers; Arlington, Virginia, United States of America (USA) (26 Apr 1977).

The nuclear energy center (NEC) concept is an approach to siting wherein nuclear facilities would be clustered in and delimited to a relatively small number of locations throughout the United States. These designated centers would be concurrently developed to their full capability over several decades, at which time, they would be several times larger than the largest nuclear power stations in existence today. The centers would be permanently dedicated to nuclear operations including the future decommissioning of functionally obsolescent facilities as well as the commissioning of their replacements. The criteria for and characteristics of an acceptable nuclear energy system that could supply most of the U.S. energy requirements in the distant future are discussed. The time period is unspecified but occurs when fossil-fuel resources are depleted to such an extent that their use is economic only in special situations, and is not economic, in general, for use as fuel.

56362 (TID—8200-R36) **Nuclear reactors built, being built, or planned in the United States as of June 30, 1977.** (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). Jul 1977. 45p. Dep. NTIS, PC A02/MF A01.

Information is tabulated on nuclear reactor and critical assembly facilities in operation, shut down, under construction or planned. The data include name, owner, location, type, power, and startup date.

56363 Experience in diagnostic and surveillance methods development. Mayo, C.W.; Zigler, G.L.; Currie, R.L. (Babcock and Wilcox Co., Lynchburg, VA). *Trans. Am. Nucl. Soc.;* **26**: 91-92(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56364 Power plant surveillance and diagnostics research and development needs. Ackermann, N.J. Jr.; Mott, J.E. (Tech. for Energy Corp., Knoxville, TN). *Trans. Am. Nucl. Soc.;* **26**: 92-93(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56365 Effect of land value on construction costs of thermal and nuclear power plants. Belyaev, V.I.; Karpov, G.G.; Nigmatulin, I.N.; Polyanskii, E.A. (All-Union Corresp Polytech Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 10, 107-113(Oct 1976). (In Russian).

A method of capacity optimization (CO) of thermal power plants (TPP) and nuclear power plants (NPP), depending on the land values (L) in the zones where they are situated, is worked out. COs

of pulverized coal, gas and fuel oil-fired TPPs and NPPs for the costs of L (thousands of roubles per hectare) equalling 10, 30, 60, 120 are determined. The necessity to take into account the costs of L when determining the capacity of TPPs with artificial reservoirs when L costs equal or exceed R. 10,000/ha, as well as for TPPs not requring artificial reservoirs and for NPPs when they equal or exceed R. 30,000/ha, is demonstrated.

56366 Nuclear power plants 1976 - international VGB congress at Stuttgart, September 7 to 10, 1976. Emendoerfer, D. (VGB Technische Vereinigung der Grosskraftwerksbetreiber e.V., Essen (Germany, F.R.)). *Atomkernenergie;* **28**: No. 4, A22-A24(1976). (In German).

From VGB congress on power plants and annual general meeting; Stuttgart, Germany, F.R. (7 Sep 1976).

Short communication only.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 56586, 56606, 56622, 56779, 56781, 56783, 56787, 56795, 56806, 56807, 56811, 56812, 56859, 56861, 56876, 56879, 56881

56367 (ORNL/NUREG—15) **Significance of reheat cracks to the integrity of pressure vessels for light-water reactors.** Canonico, D.A. (Oak Ridge National Lab., Tenn. (USA)). 16 Mar 1977. Contract W-7405-ENG-26. 31p. Dep. NTIS, PC A03/MF A01.

Reheat cracks usually manifest themselves as macroscopic defects, which are centimeters long and deep, and are detectable by the usual nondestructive examination (NDE) procedures or as microscopic grain boundary decohesions (GBD) that are beyond the limit of detection by commercial NDE procedures. This report has concentrated on the significance of the microscopic cracks that may go undetected. The probability that GBD exist in the heat-affected zones (HAZ) of weldments of pressure vessel steels is high; particularly in SA 508 Class 2 weldments. A sample of the HAZ from the prolongation-weldment from the Heavy Section Steel Technology program Intermediate Test Vessel (ITV) No. 4 was examined by the Staatliche Materialprufungsanstalt (MPA). They reported GBD 5 mm (0.2 in.) long. This prompted an examination of the HAZ from the ITV vessel that had been tested to failure at 24°C (75°F). During testing, the region of the weld which contained the flaw that initiated the failure was strained up to 0.5%. A metallographic examination of this region of the weldment revealed GBD, but none of the size reported by the MPA. Further, there was no evidence that the GBD had extended as a consequence of the tests. Fracture toughness tests were made of the HAZ of welds from ITV-4. The electron-beam welding procedure, which permits more accurate siting of the crack, was used. Fracture toughness values in excess of 220 MPa root m (200 ksi root in.) were obtained at -18°C (0°F).

56368 (ORNL/NUREG/TM—112) **Noise diagnostics for safety assessment quarterly progress report, January—March 1977.** Kryter, R.C. (Oak Ridge National Lab., Tenn. (USA)). 13 May 1977. Contract W-7405-ENG-26. vp. Dep. NTIS, PC A03/MF A01.

Noise measurements completed at Browns Ferry Units 1, 2, and 3 show that impacting of the local power-range monitor (LPRM) strings with surrounding fuel channel boxes has been eliminated and that followup measurements will not be necessary. A methodology for predicting the response of an in-core neutron detector to various noise sources has been formulated and validated. Calculations of the cross-power spectral density for two detectors axially separated in a core with random void formations are consistent with results from previous models. However, simplifying assumptions required to obtain this closed-form solution preclude its prediction of our measurements. These assumptions will not be necessary in the computerized version of the methodology being formulated from existing computer codes.

56369 (TREE-NUREG—1107) **FRAP-S2: a computer code for the steady state analysis of oxide fuel rods.** Dearien, J.A.; Bohn, M.P.; Berna, G.A.; Coleman, D.R.; Laats, E.T. (EG and G Idaho, Inc., Idaho Falls (USA)). Jul 1977. Contract EY-76-C-07-1570. 255p. Dep. NTIS, PC A13/MF A01.

This document describes the Fuel Rod Analysis Program—Steady State code (FRAP-S) and the verification of FRAP-S as a fuel rod analysis tool. FRAP-S2 (Fuel Rod Analysis Program—Steady State, Version 2) is a FORTRAN IV computer code which can be used to solve for the long term burnup response of a light water reactor fuel rod. The coupled effects of fuel and cladding deformation, temperature distribution, internal gas accumulation, and pressure and material property on the behavior of the fuel rod are considered. Fission gas generation and release are calculated as a function of burnup. The cladding deformation model includes multiaxial elasto-plastic analysis and considers creep. FRAP-S2 is a modular code with each major computational subcode isolated within the code and coupled to the main code by subroutine calls and data transfer through argument lists. A major purpose of FRAP-S2 arises because it can be coupled to versions of the transient fuel rod code FRAP-T. FRAP-S2 generates a set of initial conditions used by FRAP-T to initiate analysis of transient accidents such as loss-of-coolant (LOCA), power coolant mismatch (PCM) and reactivity initiated accidents (RIA). A material property subcode, MATPRO, which is used to provide gas, fuel, and cladding properties to the FRAP-S computational subcodes is coupled to FRAP-S2. No material properties need to be supplied by the code user. FRAP-S2 has been evaluated by making extensive comparisons between predictions of the code and experimental data. Comparisons of predicted and experimental results are presented for a range of FRAP-S2 calculated parameters.

56370 High-density fuel storage for boiling water reactors. Grimm, E.A. (General Electric Co., San Jose, CA); Zahn, L.L.; Karzmar, R.C. *Trans. Am. Nucl. Soc.;* **26**: 256-257(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56371 Optimal in-core fuel management for boiling water reactors. Lin, B.I. (Electric Power Research Inst., Palo Alto, CA); Weisman, J.; Zolotar, B.A. *Trans. Am. Nucl. Soc.;* **26**: 279(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56372 Release of fission gas from high-burnup fuel during transient heating. Rest, J.; Seitz, M.G.; Gehl, S.M. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 323-324(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56373 Spent nuclear fuel: prospects for output, storage and reprocessing. Kohn, H.W.; Park, U.Y. (Ohio Power Siting Comm). *Power Eng.;* **81**: No. 4, 84-86(Apr 1977).

One of the most serious problems facing the nuclear industry at present is the question of what is to be done with the spent fuel elements from LWRs. Currently, spent fuel is being stored, mostly at reactor sites. If storage space is not expanded, available spent fuel storage space will have been filled before 1980. The prospects for reprocessing remain dim, and the industry appears to be moving toward a de facto throwaway fuel cycle, as was predicted two years ago at the AIF fuel cycle conference.

56374 Fracture in straight pipes under large deflection conditions. II. Pipe pressures. Love, W.J.; Emery, A.F.; Kobayashi, A.S. (Univ of Wash, Seattle). *J. Pressure Vessel Technol.;* **99**: No. 1, 128-136(Feb 1977).

56375 Liner design and construction for the thorium-cooled high-temperature reactor and the safety containment at the Gundremmingen-2 nuclear power plant. Doerling, R. (LandC Steinmueller, Gummersbach, Ger.). *VGB Kraftwerkstech.;* **57**: No. 2, 81-88(Feb 1977). (In German).

Reactor pressure vessels for gas-cooled reactors and safety containments for boiling-water reactors are constructed in the form of prestressed concrete tanks. Since concrete is permeable to gas, a steel cladding (called a liner) on the inner surface of the concrete is required to ensure leaktightness. A detailed account is given of the construction, prestressing and installation of the liner for the pressure vessel of the thorium-cooled high-temperature reactor 300 at the Schmehausen nuclear power plant and of the liners for the safety containments of two boiling-water reactors at the Gundremmingen nuclear power plant. 4 refs.

56376 Water chemistry in Swedish boiling water reactors: operational experience. Fejes, P. (Allm Sven Elektr, Vasteras, Swed). *VGB Kraftwerkstech.;* **57**: No. 2, 112-116(Feb 1977). (In German).

The O$sub 2$ production from the decomposition of a small quantity of water in the reactor core is used to create a feedwater chemistry in accordance with the well-known neutral method of operation. The prerequisite for neutral operation is that the water is to a great extent kept free of dissolved electrolytes. The electrical conductivity of the water must lie in the vicinity of its theoretical value. The procedure employed in the sampling and analysis of the feedwater is described, as well as the method of ridding the condensate of dissolved and suspended corrosion products, so as to keep the electric conductivity of the feed water at the low level required for neutral operation.

56377 Airborne iodine-131 released from boiling water reactor plant. Marrero, T.R.; Smith, J.M.; Wilkinson, C.D. *Power Eng.;* **81**: No. 2, 46-47(Feb 1977).

The General Electric Co, Recently compiled and evaluated gaseous emission data from currently operating BWR plants. The total sample time for the data is equivalent to 18 reactor-years of commercial BWR operation, and runs up through June 1975. The study indicated that the data base used by the Nuclear Regulatory Commission (NRC) for 1-131 airborne emissions is not sufficiently comprehensive for realistic assessments of environmental impact evaluations. The GE study has been submitted to the NRC with recommendations for new source term values for 1-131 release rates and chemical forms. The values being recommended to the NRC for 1-131 airborne releases, based on these studies, are conservative for 1-131 airborne releases, and should be used for BWR environmental impact evaluations.

56378 Outage at Gundremmingen nuclear power plant caused by cold weather. *Energie;* **29**: No. 1, 4-5(Jan 1977). (In German).

A report is presented of an investigation, conducted to find the facts about the forced outage of the power plant. It was found that due to very low temperature and high relative humidity, the 220 kV transmission line has experienced failures of insulators and short circuits, so that power had to be switched off. The consequences of the outage are assessed and recommendations are given for action in similar cases.

56379 Behavior of active products of corrosion in the system of a channel-type boiling-water nuclear power reactor of a single-loop nuclear power plant. Gruzdev, N.I.; Shchapov, G.A.; Boguslavskii, V.B.; Petukhov, Yu.I. *Teploenergetika (Moscow);* No. 1, 70-72(Jan 1977). (In Russian).

Tests of the behavior of radioactive corrosion products in the main circulation loop, depending on the choice of the water chemical conditions and the technological conditions of plant operation, are reported. An evaluation of the capacity of different structural materials (stainless steel, zirconium alloys, carbon steel) to sorb radioactive isotopes contained in the heat carrier is made. It is found that zirconium alloys possess the highest sorptional capacity. They are followed by carbon steel and, finally, stainless steel.

56380 Treatment of the influence of irradiation in design and operation control of pressure vessels of pressurized- and boiling-water reactors. Leitz, C. (Kraftwerk Union A.G., Erlangen (Germany, F.R.). Reaktortechnik). *Atomkernenergie;* **29**: No. 2, 75-81(1977). (In German).

From Technical meeting on radiation exposure and damage of reactor components outside the reactor core; Stuttgart, Germany, F.R. (23 Sep 1976).

14 figs.; 3 tabs.; 39 refs.

The report shows how the influence of neutron irradiation on material properties is treated in the safety calculations for pressure vessels of KWU pressurized- and boiling-water reactors. The material properties which are important with respect to irradiation and the methods of their measurement are described. These properties are the NDT (nil ducility transition) temperature, the reference temperature RTsub(NDT) and the fracture toughness. The modified Porse's diagram and the fracture mechanics diagram used for the safety calculations are based on these properties. The irradiation-induced shifts of NDT temperature or RTsub(NDT) or fracture toughness vs. temperature curves, respectively, usually are measured by charpy-V tests. Design curves for conservative prediction of those shifts as a function of neutron fluence and copper content are presented. These curves are derived from literature data based on the so-called 30 ft lb criterion. The predictions are tested and perhaps corrected during reactor operation by examination of surveillance samples irradiated under accelerated neutron flux in the pressurized-water reactors. The standard surveillance program for KWU pressurized-water reactors is described, and as an example, the results of the surveillance program of the Karlsruhe power reactor MZFR are reported. In this special case of a heavy-water moderated reactor, damage-function calculations were applied to refer the near core irradiation results to the vessel wall.

56381 Experimental evaluation of the fast neutron fluence for the KRB reactor pressure vessel and its operational relevance. Eickelpasch, N.; Seepolt, R. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen/Guenzburg (Germany, F.R.)). *Atomkernenergie;* **29**: No. 2, 149-152(1977). (In German).

From Technical meeting on radiation exposure and damage of reactor components outside the reactor core; Stuttgart, Germany, F.R. (23 Sep 1976).

9 figs.

The reactor pressure vessel of the Gundremmingen nuclear power station was manufactured from the waterquenched steel 20NiMoCr26 (ASTM A 508 cl.2). When this power station was constructed (1962-66) only limited information was available about the neutron irradiation behaviour of this steel. Therefore an extensive irradiation program was planned early and performed. Since 1972 this program is completed. The most important results and its consequences are reported. Tensile test and Charpy-V notch test specimen were installed in the reactor prior to operation to enable the accurate measurement of any changes of the mechanical properties of the vessel material throughout the vessel lifetime. These samples together with neutron activation monitors were arranged in the vessel in such a manner to provide early (after one cycle operation) the pertinent information in regard to the 40-year neutron fluence of the pressure vessel. The fast neutron flux ($E < 1$ MeV) between the core shroud and the pressure vessel wall was determined by the evaluation of the activation monitors. The result of these measurements are in good agreement with MAC-RAD shielding calculations. Accordingly the anticipated 40 year (80%E load factor) fast fluence of the pressure vessel wall will be 4.7×10^{19} cm^{-2}. The influence of neutron irradiation on the 5.2 kpm/cm^2 ductility for this material is shown. The operational consequences are given as a correlation between accumulated thermal output of the reactor and the minimum vessel temperature, which has to be maintained during 'cold' pressurization tests.

56382 Operating U.S. power reactors. Cottrell, W.B. *Nucl. Saf.;* **18**: No. 1, 95-101(1977).

Reactor availability, unit capacity and availability, and forced outage rate are tabulated. Other information includes significant changes in the operating status of facilities (e.g., changes in licensed power levels and changes in operating limits), regulatory-agency-imposed shutdowns, and new inspection requirements. 6 refs.

56383 Novel design for LWR pressure vessel nozzles and corresponding stress analysis. Reynen, J. (Euratom, Ispra, Italy); De Windt, P.; Widart, J.; Scailteur, A.; Henin, R.; Laurent, P.; Morelle, L. pp 263-271 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

The paper describes a novel design of LWR pressure vessel and the corresponding stress analysis. This hereafter named "integral vessel" design consists of integrating the main part of the nozzles and of the support pads into the prolongated flange. Compliance with stress intensity limits of ASME Code Section III is demonstrated.

56384 High pressure vessel flange behavior under transient thermal loadings. Spaas, H.A.C.M.; Latzko, D.G.H.; Bakker, A. (Delft Univ. of Tech., Netherlands). pp 293-309 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

Experimental and computational data are presented on the behavior of high pressure vessel flanges, notably for LWR applications, during thermal transients. This behavior is governed by two opposite effcts, caused by bolt lag and by thermal gradients between the flange rings and their adjacent shell parts, respectively. Conclusions are drawn concerning the effect of thermal transients on leak tightness and on bolt fatigue life.

56385 Improvement of fracture toughness in reactor pressure vessel steel plates. Kunitake, H. (Nippon Steel Corp., Tokaishi, Japan); Nakao, H.; Kikutake, T.; Saito, A.; Ishiguro, T.; Takeda, T. pp 603-611 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

The improvement of fracture toughness in pressure vessel steels has been of great interest from the standpoint of integrity in lightwater reactors, and these steels are now required to possess high fracture toughness under the new codification, code revisions and regulations. Several metallurgical factors contributing to the improvement of fracture toughness were investigated, and the results were applied to the production of reactor pressure vessel steel plates. As a result, high fracture toughness satisfying the design basis of pressure vessels was obtained. The steel thus produced was also found to possess low susceptibility to underclad cracking and good weldability.

56386 Assessment of toughness and cracking in the heat-affected zone of light water reactor components. Kussmaul, K.; Ewald, J. (Univ., Stuttgart). pp 627-646 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

Basic investigations on the heat-affected zone (HAZ) of component weldments involving testing of simulated samples have provided information on the possible decrease of toughness and/or the susceptibility to cracking due to the thermal-mechanical history of

the component. The different steel types are classified according to the embrittlement and cracking behavior. Outstanding problems concerning the real lower bound toughness properties, and the significance with regard to the integral resistance of the component lead to a requirement for optimization of manufacturing processes and the introduction of new developments. In parallel with these aspects is the need to evaluate the real safety margin by applying additional testing concepts in the framework of a Water Reactor Safety Research Program on "Safety of Components."

56387 Fatigue behavior of nozzles of light water reactor pressure vessel model. Miyazono, S.; Ueda, S.; Kodaira, T.; Shibata, K.; Isozaki, T.; Nakajima, N. (Tokai Research Establishment, Japan). pp 741-748 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

The experimental results of a cyclic internal pressure test are described on a pressure vessel model, in which three kinds of nozzle models were welded. In the inner corner surface of each nozzle two kinds of artificial cracks were machined perpendicular to the direction of maximum circumferential stresses, which occur at both the head and bottom sides. Cyclic internal pressure was given from zero to 10.8 MN/m^2 by oil after the strain distribution of the inner and outer surface of each nozzle was examined by static internal pressure of 10.8 MN/m^2. In the cyclic internal pressure test, the fatigue crack length from the artificial cracks at any pressure cycles imposed was measured by an electrical resistance method and crack gages.

56388 Energy storage in the form of latent heat. Taube, M.; Pinto, S (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland). Abt. Isotopenproduktion). *Energie;* **28**: No. 12, 357-358(Dec 1976). (In German).

2 figs.; 3 refs.

A system for LWR reactors is proposed in which the excess energy produced is stored outside peak-load periods. The working medium is a eutectic mixture of salts with a relatively high heat content.

56389 Investigation of operating conditions of nuclear power plants during emergency shortages of power in the electric power system. Airapetyan, Yu.I. (Erevan' Polytech Inst im. K. Marksa, Arm SSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 12, 3-9(Dec 1976). (In Russian).

Dynamic operating conditions of nuclear power plants with water-cooled reactors arising during breakdown shortages of power in an electric power system are investigated. A mathematical model of the investigated processes, realized on a computer, is worked out. Calculations are carried out for different values of shortages and power reserves and for different programs of control of the reactor power. An analysis of the results obtained shows that, as a result of a high reactor response and self-regulation, nuclear power plant units with water-cooled reactors can effectively be utilized for emergency control of the frequency and capacity of the power system.

56390 Nuclear power industry in the tenth five-year plan period. Rassokhin, N.G.; Voronin, L.M. (Moscow Energ Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 12, 59-63(Dec 1976). (In Russian).

In 1976, the capacity of nuclear power plants in the USSR amounted to 6 MW. In 1976-1980, 13-15 MW of capacity are to be put into operation, all of them in the European part of the USSR. Most of them will be two-loop plants with water-cooled reactors and single-loop plants with boiling water uranium-graphite channel reactors. Development of fast breeder reactors will continue. After a stable and intense thermonuclear reactor has been obtained on the Tokamak-10 research fusion reactor, the next step will be the design of a demonstration thermonuclear reactor.

56391 Neutron-flux instrumentation for a boiling water reactor. Wear, J.I. (Plessey Telecommun, Poole, Eng.). *Syst. Technol.;* No. 25, 6-13(Dec 1976).

British RandD activities in nucleonics, and in particular the instrumentation for power-producing reactors are reported. To meet the needs of the reactor designer, a multi-disciplinary team of physicists, mechanical, electrical and electronic engineers has been built up to cooperate in the design of systems which are frequently unique. Such a system now described is an in-core neutron-flux instrumentation package for a boiling water reactor. Selected aspects are described in sufficient detail to explain the technologies involved. 1 ref.

56392 Effect of pellet cracking on light water reactor fuel temperatures. MacDonald, P.E.; Weisman, J. (Idaho Natl Eng Lab, Idaho Falls). *Nucl. Technol.;* **31**: No. 3, 357-366(Dec 1976).

A model that accounts for the effects of fuel pellet cracking on both fuel conductivity and gap conductance is formulated. Fuel centerline temperature measurements were made during the steady-state irradiation in the Halden Heavy Boiling Water Reactor of four typical LWR-type test rods with varying fuel density and pellet-to-cladding gap sizes. Calculations using the cracked pellet model were compared to the in-pile temperature measurements, and good agreement was obtained.

56393 Nuclear reactor with a containment and reactor pressure vessel and a pressure suppression vessel arranged in the containment. Kuschel, D.; Mueller, W.F.; Schlosser, G.; Zeitzschel, G.; Voss, A. (to Licentia Patent-Verwaltungs-G.m.b.H., Frankfurt am Main (Germany, F.R.)). German(FRG) Patent 2,023,343/C/. 11 Nov 1976. 4p. (In German).

3 figs.

The invention relates to a nuclear reactor with a containment and a reactor pressure vessel and a pressure suppression vessel arranged in the containment, the reactor pressure vessel being arranged in a pressure chamber of such strength that it withstands the pressure freed during rupture of the reactor pressure vessel. This pressure chamber has connections to the pressure suppression system the free cross sections of which are, on the whole, dimensioned in such a way that the amount of vapor passing after the rupture of the reactor pressure vessel corresponds nearly to the condensation capacity of the pressure suppression vessel.

56394 Investigation of conditions of operation of nuclear power plants with water-cooled power reactors. Akkerman, G.; Khampel, R.; Kertsher, F.; Khentshel, G.; Lyuttsov, K. (Higher Eng Sch, Zittau, E Ger). *Teploenergetika (Moscow);* No. 11, 85-87(Nov 1976). (In Russian).

Problems of correlation of operating conditions of nuclear power plants to save nuclear fuel are considered. In particular, problems of optimization of nuclear fuel charging, especially of the operation of a nuclear power plant at below-capacity level, and the problem of stability of operation of nuclear power plants with water-cooled reactors taking into account their specific conditions (partial fuel overloads, change in the reactivity of the reactor following capacity change) are considered. Two interconnected problems are discussed: selection of such a succession of partial overloads that would ensure minimum costs of the electric power produced; and increase of the reactor campaign by reducing its capacity.

56395 On two-phase thermal boundary layer along heated walls. Cumo, M.; Farello, G.E.; Nozzi, P.; Ferrari, G.; Montanari, M. (TERM-RIS-CSN, Italy). *Termotecnica (Milan);* **30**: No. 11, 579-591(Nov 1976).

The development of two-phase thermal boundary layers along heated walls is studied. Its knowledge is relevant to the understanding of the mixing among subchannels in LWR's rod bundles, the onset of post burnout, the prediction of the void fraction in the subcooled region of PWR's, etc. Basically, along a heated wall cooled by a parallel flow of subcooled liquid, when the wall temperature exceeds the saturation temperature of the amount needed for the boiling to start, two characteristic boundary layers begin to develop, with increasing thicknesses; a bubble layer, constituted by a series of bubbles of increasing dimensions, more or less separated from each other, and a liquid thermal boundary layer, which exceeds and envelopes the bubble layer. This outer layer has an irregular contour and may be clearly visualized by means of schlieren techniques. Despite their apparent irregularity and the roughness of their shapes, both boundary layers show at a first glance, an increasing trend both with the surface flux and the bulk temperature (decreasing the degree of subcooling).

56396 Safety and security of nuclear power reactors to acts of sabotage. (Sandia Lab, Albuquerque, NM). *Nucl. Saf.;* **17**: No. 6, 665-670(1976).

A study has been made of the vulnerability of U.S. commercial light-water reactor power plants to sabotage. The susceptibility of nuclear plants to sabotage and the consequences of a successful attack are compared with respect to other industrial and civil targets. Recommendations are given to further reduce the vulnerability of nuclear power plants to sophisticated sabotage threats. 9 refs.

56397 Steam generator tube failures: world experience in water-cooled nuclear reactors in 1975. Hare, M.G. Mississauga, Ont.; Atomic Energy of Canada Ltd. (1976). vp.

Steam generator tube failures were reported in 22 out of 62 water-cooled nuclear power plants surveyed in 1975. This was less than in 1974, and the number of the tubes affected was noticeably less. This report summarizes these failures, most of which were due to corrosion. Secondary-water chemistry control, procedures for inspection and repair, tube materials, and failure rates are discussed. 16 refs.

56398 Experimental and analytical studies for a BWR nuclear reactor building: evaluation of soil-structure interaction behavior. Mizuno, N.; Tsushima, Y. (Chubu Electr Power Co, Nagoya, Jpn). *Takenaka Gijutsu Kenkyu Hokoku;* No. 16, 34-47(1976).

A method is presented for estimating damping effects based on constant complex stiffness. Structural damping effects and the dynamic soil-foundation stiffness are approximated by linear or quadratic functions of eigenvalues. An approximate evaluation is presented of the experimental results on the No. 1 reactor building (BWR) of Hamaoka Nuclear Power Station. A simulation study is discussed, in which a forty-eight degree of freedom spring mass system is used, based on eight masses for the eight floors including the base foundation and the six degrees of freedom for each mass. Through these studies, it is concluded that radiation damping has a great effect in the reactor building, and the method discussed is reasonable for estimating the damping effects in soil-structure interaction.

56399 Apparatus for inspecting failed fuel. Fujino, M.; Nishi, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-98,497/A/. 26 Feb 1975. 4p. (In Japanese).

Object: To provide a sample vessel, frontwardly of a gamma-ray detector, in communication with a fuel bundle and a reactor through a valve, the valve being controlled by a timer, to automatically inspect failed fuel. Structure: A pump is driven for a given period of time to introduce reactor water from the fuel bundle into the sample vessel for a given period of time, after which radioactivity intensity signal within the reactor water detected by the gamma-ray detector is fed to an energy analyzer started by stop signal of the pump to analyze energy of the radioactivity for purpose of detecting presence of failure of fuel, and thereafter, the valve is opened by the signal indicative of energy analyzing completion to return the reactor water within the sample vessel to the reactor and another valve opened to supply wash water to wash the interior of the sample vessel.

56400 Apparatus for inspecting failed fuel. Fujino, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-9,496/A/. 26 Feb 1975. 4p. (In Japanese).

Object: To provide electrode rods on an inner surface of a shipper cap and pressure detectors in the form of microswitches on four sides of the outer surface thereof to positively set the shipper cap to the channel and to positively separate reactor water within the channel from ambient reactor water. Structure: When the shipper cap is set on the channel, the four sides of the cap come into contact with a grid plate to upwardly move each rod against a return spring, and each microswitch is actuated through contact to light the indicating lamp, after which air is fed into the shipper cap to move a water level of reactor water within the channel from the electrode, thus separating from the ambient reactor water for subsequent operation for inspecting failed fuel.

56401 Fuel assembly in a reactor. Suzumura, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-96,992/A/. 21 Feb 1975. 4p. (In Japanese).

Object: To restrain expansion and deformation of a channel box resulting from rise in output to prevent leakage of coolants. Structure: A fuel assembly in a reactor, in which a plurality of fuel elements are arranged orderly, said elements having upper and lower ends fixed by upper and lower tie plates and having outer peripheral portions surrounded by a channel box, a flat spring member being retained between the lower tie plate and the fuel element positioned in the outermost periphery of the bundle of fuel elements to resiliently support the lower end portion of the channel box.

56402 Method and apparatus for failed fuel detection. Kamiya, K.; Yusa, H.; Oda, A. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-91,492/A/. 10 Feb 1975. 6p. (In Japanese).

Object: To diffusibly charge from the bottom gases into a fuel assembly immersed in a cooling liquid to thereby detect presence of fuel breakage quickly and with high accuracy according to density of impurities adhered to the gases. Structure: A recirculating pump is started to actuate a jet pump within a reactor for circulation of cooling liquid through the core bottom, fuel assembly and gas-and-liquid separator, and a gas charging means is actuated to charge air or the like into the circulating cooling liquid through an air intake pipe, said air being formed into air bubbles, to adsorb gaseous impurities adhered to the broken part of fuel rods and gaseous impurities contained in the cooling liquid to be recovered into a gas storage and a gas collector, after which said impurities are introduced into an impurity analyser through a sampling pipe or the like to detect presence of breakage of the fuel rod according to density of the impurities.

56403 Fuel assembly. Yamashita, J. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-89,991/A/. 5 Feb 1975. 4p. (In Japanese).

Object: To provide a fuel assembly, which is designed to be able to invert upper and lower positions during the life of burning to recharge fuel into the core, thereby improving an influence exerted on formation of plutonium isotope and unlimited multiplication factor caused by deviation of percentage of voids in the core of a boiling water reactor. Structure: A number of fuel rods whose upper and lower ends have the same construction are encased in a channel box, and tie plate and channel fastener are attached to the upper and lower ends of the fuel rods to form a fuel assembly in vertically asymmetrical relation.

56404 Fuel assembly. Shimoshige, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-86,687/A/. 27 Jan 1975. 4p. (In Japanese).

Object: To enhance the effect of reactivity with respect to insertion of control rod without decreasing control rod worth at the lower part of a reactor core thereby enabling flattening power distribution. Structure: A fuel assembly in a boiling water reactor wherein a fuel pellet at an axial lower half portion comprises a mixed plutonium-uranium oxide fuel to which uranium dioxide and plutonium dioxide are added and mixed.

56405 Water supply system. Matsumura, J. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-85,094/A/. 24 Jan 1975. 3p. (In Japanese).

Object: To avoid scram of a reactor due to reduction of the reactor water head at the time of trip of water supply pumps. Structure: A reservoir pressurized by a pressurizing gas such as nitrogen gas is connected to the outlet duct of a reactor water supply pump. At the time of trip of the water supply pump a great quantity of water is temporarily supplied to cover shortage of supply water until the start of a spare pump is completed thereby to prevent the lowering of the reactor water head.

56406 Method of detecting and correcting reactor water level. Asami, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-85,093/A/. 22 Jan 1975. 5p. (In Japanese).

Object: To correct the relation between the apparent detection water head of a reactor water head gauge in a safety protection system and an interlock set point according to recirculation flow thereby to permit the reactor water head gauge in the safety protection system to always function safely irrespective of a change in the recirculation flow of the reactor. Structure: A recirculation flow signal taken out of a recirculation flow detector is converted into a suitable signal via a signal converting section consisting of a function generator and a signal converter. The signal is coupled to an indicating section of the reactor water head gauge of the safety protection system so as to correct the interlock set point within the indicating section.

56407 (NP-tr—1979) **Okarshamn Reactor, Unit 1. Ramp test program.** 1975. Translation of Swedish report. 38p. NTIS.

The proposal consists of a test program with data on detailed procedure. A later and approved version of the program will give the basis for an operational order. The attached backup for calculations shows fairly well the power curve for the test region. The final data will be calculated shortly before the test, so that the conditions will be as real as possible. The test is designed to check the fuel's tolerance of relatively fast power increases to levels above those at which the fuel had previously operated.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 56367, 56369, 56372, 56382, 56383, 56384, 56385, 56386, 56387, 56388, 56389, 56390, 56392, 56394, 56395, 56397, 56606, 56608, 56622, 56721, 56767, 56769, 56770, 56773, 56779, 56781, 56783, 56787, 56797, 56798, 56806, 56807, 56808, 56809, 56810, 56811, 56812, 56859, 56861, 56864, 56876

56408 (TREE-NUREG—1058) **Semiscale Mod-1 system response during the ECC baseline test series (design of the Mod-1 baseline ECC test).** Langerman, M.A. (EG and G Idaho, Inc., Idaho Falls (USA)). Jun 1977. Contract EY-76-C-07-1570. 66p. Dep. NTIS, PC A05/MF A01.

The baseline ECC test which is to be used in comparison with future Semiscale Mod-1 ECC related tests is specified using results from the baseline ECC test series. Test results which led to the selection of appropriate baseline ECC conditions are evaluated. The major parameters investigated include the effects of (a) ECC system specifications including ECC system scaling, and lower plenum ECC injection, (B) lower plenum scaling, and (c) unpowered rods simulating the effects of PWR control rod guide tubes and instrument thimbles.

56409 (WCAP—8183(Rev.6)) **Operational experience with Westinghouse cores (up to December 31, 1976).** Schreiber, R.E.; Iorii, J.A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Jun 1977. vp. Electric Corp., Pittsburgh, PA.

The cumulative operating experience of Westinghouse Zircaloy-clad fuel rods and other associated core components up to December 31, 1976, is studied. Westinghouse experience with Zirca-

loy fuel is summarized and a fuel experience overview, including fuel performance for generic problems common to a number of plants along with solutions to these problems, is presented. Other core component experience is also discussed.

56410 (JPRS—69404) Translations on Eastern Europe. 11 Jul 1977. Translation of Scientific Affairs No. 552. 60p. NTIS.

The serial report contains articles concerning the development of and progress in the various theoretical and applied scientific disciplines and technical fields; and the administration, structure, personnel, and research plans of leading East European scientific organizations and institutions, particularly the academies of sciences. Several studies concern the Kozloday Nuclear Power Plant.

56411 Westinghouse high-density spent fuel rack design. Spier, E.M.; Kaminski, D.J.; Rawley, C.J.; Nowicki, J.A. (Westinghouse Electric Corp., Pittsburgh). *Trans. Am. Nucl. Soc.;* **26**: 257(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56412 B and W-designed close-spaced fuel storage racks. Olszewski, J.S.; Clark, R.H. (Babcock and Wilcox Co., Lynchburg, VA). *Trans. Am. Nucl. Soc.;* **26**: 258-259(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56413 Iran-1 and Iran-2 nuclear power station on the Persian Gulf. Altvater, W. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 2, 74-80(Feb 1977). (In German).

8 figs.; 2 tabs.; 5 refs.

Iran is a country with large oil reserves which, however, are exploited only very carefully because of ther importance for exports. In the light of this policy it was decided to make increasing use of nuclear energy for the country's electricity supply. Under the 8th Iranian five year plan, a total installed generating capacity of 56,000 MW is foreseen by 1993, of which 24,400 MW will be in nuclear power plants. This large construction program of nuclear power stations is implemented by the Atomic Energy Organization of Iran, AEOI, which started negotiations with nuclear industries of various industrialized countries in early 1974. In November 1974, these discussions led to a letter of intent with the German Kraftwerk Union AG (KWU) for the turnkey erection of the first Iranian nuclear power plant, Iran-1 and Iran-2, with two units of 1,300 MW on a site on the Persian Gulf. The siting decision was taken in favor of the Halileh area located some 18 km from the seaport of Bushehr. Construction work on the site began in July 1975. The delivery dates are December 1, 1980 for Iran-1 and November 1, 1981 for Iran-2.

56414 Angra-2 and -3 nuclear power plants in Brazil. Herzog, G. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 2, 81-86(Feb 1977). (In German).

8 figs.; 1 tab.; 8 refs.

After a letter of intent had been given in June 1975. Firnas Centrais Eletricas as the builder-owner have signed contracts for the erection of the Angra-2 and Angra-3 nuclear power plants, together with Kraftwerk Union AG, NUCLEBRAS and NUCLEN, in July 1976. Apart from a description of site, location, and power station, the organisation of construction is given in a schedule.

56415 Preparing for electrical-system startup at a nuclear power plant. Boissy, G.J. (Fla Power and Light Co). *Power (N.Y.);* **121**: No. 2, 96-100(Feb 1977).

Experience at St Lucie Unit No. 1 nuclear power plant regarding organization for electrical startup is related and analyzed. Problems of staffing, organization procedures, test standard development, and implementation of the program are considered.

56416 Neutron flux calculations with regard to radiation damage, explained for the geometry of a KWU 1300-MWe PWR facility. Koban, J. (Kraftwerk Union A.G., Erlangen (Germany, F.R.). Reaktortechnik). *Atomkernenergie;* **29**: No. 2, 159-162(1977). (In German).

From Technical meeting on radiation exposure and damage of reactor components outside the reactor core; Stuttgart, Germany, F.R. (23 Sep 1976).

4 figs.; 7 refs.

Neutron flux calculations are described for the example of a KWU 1300-MWe PWR facility. Geometrical models and two-dimensional power distributions used in fixed source calculations are explained. The calculations are carried out by the transport codes ANISN and DOT-3 using the 100 group DLC-2 neutron cross section library. The problem of variable neutron spectra in irradiation positions and in the vessel wall is solved by weighting the neutron spectra by damage functions or by calculating the primary damage by the use of displacement cross sections. Problems arise in calculating the spectrum-weighted cross sections of the reactions mentioned above, because of the different cross section curves, which we can obtain from several publications. An international recommendation of uniform microscopic cross section sets would help to make comparable the results, which have been elaborated by different institutions. A comparison between theoretical fluence values and those obtained by monitor activity measurements, which have been carried out in power plants already in operation, shows agreement within 30%.

56417 Inservice inspections of primary components on the nuclear power plant Obrigheim. Boedecker, K.W. (Kernkraftwerk Obrigheim G.m.b.H., Obrigheim/Mosbach (Germany, F.R.). Abt. Maschinentechnik). *Atomkernenergie;* **29**: No. 2, 145-148(1977). (In German).

From Technical meeting on radiation exposure and damage of reactor components outside the reactor core; Stuttgart, Germany, F.R. (23 Sep 1976).

1 tab.

Inservice inspections in the nuclear power plant Obrigheim are carried out in accordance with the experts of the license authority. Due to the present radiation levels special methods for the performance of nondestructive inspections and the replacement of parts of the isolations were necessary. Automatic equipment for inservice inspections of reactor pressure vessels is sufficiently developed, and for other components of the primary circuit prototype manipulators are available. In addition to the brittle fracture control of the reactor pressure vessel a special radiation program is provided.

56418 Benefit of using a global tridimensional finite element calculation for the analysis of the primary part of a PWR steam generator. Phan-Ngoc, K.; Billon, F. (FRAMATOME, Courbevoie, France). pp 39-44 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

The report presents the results of a tridimensional finite element analysis of the primary part of a PWR steam generator and discusses its precision and the improvements that it provides for understanding the behavior of the vessel by comparing its results to those of a bidimensional analysis and to experimental measurements. The limitation of the three dimensional analysis for appreciating the behavior of the vessel towards failure is discussed, in the frame of the criteria of the ASME Code. Finally views are presented on the strategies for performing the structural analysis of nuclear pressure vessels.

56419 Thermoplastic analysis of a pump body in a primary circuit nuclear application. Baylac, G. (EDF, Paris); Lecarpentier, P.; Charras, T.; Clement, G. pp 157-167 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

A finite element analysis has been carried out to study the elastic-plastic deformations of a pump casing in a primary circuit nuclear application. Essentially two different problems have been looked at, the determination of the pressure induced stresses in the pump body, and the effect of thermal gradients on deformation in the region of the upper flange. The thermoplastic finite element analysis was carried out using the codes developed by the French Atomic Energy Commission (C.E.A.). Under a pressure of 2.5 times the design pressure no plastic instability was found. The severe temperature gradients in the flange led to a large initial deformation, which quickly stabilized after several cycles, no matter which strain hardening law was adopted (isotropic or kinematic).

56420 A-508 class 3 forgings for pressure vessels. Comon, J. (Creusot Loire, La Creusot, France). pp 957-970 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

The manufacture of the forged parts of the first PWR nuclear pressure vessel installed in France started in the Creusot-Loire's Forge Plant in 1961. Since this date, more than 300 forgings of this type were delivered (flanges, rings, zones, and nozzles). The major part of these forgings were made of Mn, Ni, Mo steel (SA 508 class 3). They represent a population large and homogeneous enough to attempt a statistical analysis of chemical and mechanical test results. The aim of this analysis was double: (1) a better knowledge of the scattering of the results and a better estimate of what can be introduced or accepted in a specification, and (2) the setting up of correlations existing between these results, particularly between chemical analysis and mechanical test results. In addition to this statistical analysis concerning industrial results, several laboratory studies are presented, giving a more complete characterization of SA 508 class 3. All these results form a very complete documentation showing that SA 508 class 3 steel is suitable for the manufacture of large forged vessels requiring a high degree of reliability.

56421 Production of components for pressurized water reactors in the plants of FRAMATOME. Gandrey, L. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 71 - Chalon-sur-Saone (France)); Moreau, B. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 71 - Le Creusot (France)). *Kerntechnik;* **18**: No. 12, 518-523(Dec 1976).

7 figs.; 2 tabs.

The manufacture of pressure vessels and steam generators for pressurised water reactors of 900 MW electric power output in the production plants of FRAMATOME are described. After describing the different manufacturing phases, the authors go into the question of quality assurance. Since 1975 the steam generators have been built at a plant at Chalon-sur-Saone; the pressure vessels are produced at the plant at Le Creusot which started production in 1973.

56422 Production of components for pressurized water reactors in the plants of Framatome. Gandrey, L.; Moreau, B. (Framatome, Chalon-sur-Saone, Fr). *Kerntechnik;* **18**: No. 12, 518-523(Dec 1976).

The manufacture of pressure vessels and steam generators for pressurized water reactors of 900 MW electric power output in the production plants of Framatome are described. After describing the different manufacturing phases, the authors go into the question of quality assurance. Since 1975 the steam generators have been built at a plant at Chalon-sur-Saone; the pressure vessels are produced at the plant at le Creusot which started production in 1973.

56423 Reports from water practice. The condensate purification system in the nuclear power plant at Doel. Roofthooft, R. (Laboratoire Belge de l'Industrie Electrique (LABORELEC), Rhode-St. Genese). *VGB Kraftwerkstech.;* **56**: No. 10, 645(Nov 1976). (In German).

1 figs.

Due to the changing cooling water quality and the problems to be expected in condenser tube leakages due to these changes, a condensate purification system was installed in each power station unit.

56424 Investigation of the functioning of an industrial process. Hennebicq, J.P. (Ec Natl Super de l'Aeronaut et de l'Espec, Toulouse, Fr). *Automatisme;* **21**: No. 10, 315-322(Oct 1976). (In French).

Process operation studies often require a model based on the knowledge of physical parameters obtained by theoretical analysis and/or a representation model derived from experiments. This paper shows the usefulness of simplified operation model which constitutes an attempt at a compromise between the two types of approaches. Such a model simulating a pressurized water nuclear plant has been used for the development of control loops at low power and for the study of the behavior of the plant in the electrical distribution grid. For a new system design, this method should make the preliminary studies of sensitivity easier.

56425 Neutron noise analysis as a diagnostic method of mechanical vibrations in WWER type reactor core components. Dach, K.; Pecinka, L. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). *Jad. Energ.;* **22**: No. 8, 296-301(Aug 1976). (In Czech).

The possibilities and constraints are discussed of the method of the inspection of the mechanical vibrations of control rods, fuel elements and of the relative movement of the pressure vessel body and the core catcher using the analysis of neutron noise. The mathematical formulation of the mentioned three tasks is made and the possibilities of the experimental verification of the method on an SR-0A reactor are indicated.

56426 Complex solution of linear dynamics of WWER-44o nuclear power plant. Stirsky, P. *Jad. Energ.;* **22**: No. 8, 310-317(Aug 1976). (In Czech).

The block diagram and the mathematical model of the calculation of a linearized case of the dynamics of a WWER-440 power plant are presented. The results of transient characteristics are given for three selected types of accidents: reactivity accident, the failure of the valve opening of the first turbine and the disturbance of the coolant flow of one of the six steam generators.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 55593, 56606, 56609, 56612, 56613, 56614, 56727, 56802, 56803, 56804, 56805, 57139, 57808

56427 (BNWL—2239) Feasibility of monitoring the strength of HTGR core support graphite: Part I. Morgan, W.C.; Becker, F.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Mar 1977. Contract EY-76-C-06-1830. 54p. Dep. NTIS, PC A04/MF A01.

The results reported herein establish the technical feasibility of a method for monitoring the strength of HTGR core support structures in situ. A correlation has been established between changes in the velocity of an ultrasonic pulse and changes in strength which occur during oxidation; moreover, that correlation is practically independent of oxidation profile in the posts. In addition, other correlations have been developed which allow very precise predictions of the unoxidized strength from measurements of sonic velocity and density.

56428 (CONF-770708—5) Interaction of LaC_2 and NdC_2 with SiC in HTGR particles. Pearson, R.L.; Lindemer, T.B. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

From Thermal reactor safety meeting; Sun Valley, Idaho, United States of America (USA) (31 Jul 1977).

The reaction rate of either NdC_2 or LaC_2 kernels with SiC in coated particles similar to those used in a High-Temperature Gas-Cooled Reactor (HTGR) is essentially identical with that observed in irradiated, TRISO-coated HTGR fuel particles containing UC_2. The reaction apparently results from destructive distillation of the rare-earth dicarbide in the kernel, transport of rare-earth metal gas down the temperature gradient, formation of the dicarbide at the SiC-pyrocarbon interface, and solution of the SiC in the dicarbide along the SiC grain boundaries. The reaction rate necessary to cause SiC coating failure in four years would apparently be achieved at temperatures above approximately 1565K. It appears that much less than 0.003 of the fissile fuel could fail from this reaction; this compares with a proposed large HTGR design failure fraction of approximately equal to 0.0039 for the fissile fuel.

56429 (GA-A—14381) Gas turbine HTGR program. Quarterly progress report for the period ending March 31, 1977. (General Atomic Co., San Diego, Calif. (USA)). Apr 1977. Contract EY-76-C-03-0167. vp. Dep. NTIS, PC A04/MF A01.

The report describes early conceptual studies of a 2-loop intercooled 3000 MW(t) plant which, together with existing conceptual designs of a 3-loop intercooled 3000 MW(t) plant, can be compared with designs being studied by the HHT Project. The objective of this effort is to determine a basis for a common development program and demonstration plant. The 2-loop intercooled design is compared to the 3-loop nonintercooled 300 MW(t) reference design of General Atomic Company. The turbomachine increased in rating from 400 to 620 MW(e) and in length from 37 to 52 ft. The larger heat exchangers required caused the PCRV diameter to increase from 118 to 128 ft and the height from 111 to 125 ft. The system pressure losses increased from 7.15 to 10.60%. The plant efficiency increased from 39.6 to 41.2%. Initial indications are that the increase in efficiency roughly balances the increased cost of the reactor turbine system.

56430 (NP—22192) Preliminary systems-engineering study of an advanced nuclear-electrolytic hydrogen-production facility. Escher, W.J.D. (Institute of Gas Technology, Chicago, Ill. (USA)). Mar 1976. 13p. of Gas Technology, Chicago, IL.

An assessment of the production cost of pipeline hydrogen (at 1000 psi) using nuclear energy and water electrolysis in an advanced-technology, fully-dedicated facility is presented. Estimates have been made of the overall efficiency of this production process in terms of nuclear reactor heat and the higher heating value of the product hydrogen. Both the costs and efficiency estimates have been compared with corresponding values associated with a "contemporary technology" nuclear-electrolytic hydrogen-production facility concept, developed as a baseline in the study. This conceptual-level study found that (1) the cost of hydrogen can be reduced by approximately half and (2) overall energy conversion efficiency can be raised from about 25 percent to 43 percent, by utilizing the advanced-technology facility. However, a moderate R and D effort would be required to establish the assumed "1985 technology" base predicated for this facility concept. No attempt was made to assess R and D costs. Actual pipeline hydrogen-production costs projected by the study (stated in mid-1975 dollars) range downward from a nominal case of $5.07/million Btu to as low as $3.15/million Btu, where (1) credit is taken for oxygen byproduct at $10/ton, (2) a very high (90 percent) plant capacity can be achieved, and (3) larger (4000 MWth vs. 3000 MWth) high-temperature gas-cooled reactors (HTGR) units can be used and multiple adjacent units can be constructed (as opposed to a single unit). Such a large-scale nuclear hydrogen-production complex ("Hyplex"), consisting of 6 to 8 reactor units, could service a 48-inch pipeline at 1000 psi for operation at near optimal conditions for future gas energy delivery. The energy delivery rate of such a system would be about 0.25 quadrillion Btu/year.

56431 Investigation of high-temperature reactor heat exchanger materials. Serpekian, T.; Hecker, R. (Kernforschungsanlage, Juelich, Ger.). *Nucl. Technol.;* **34**: No. 2, 269-289(Jul 1977).

Investigations of the compatibility of steam generator or heat exchanger materials of a high-temperature nuclear reactor with both the primary and the secondary media of the coolant circuits were conducted. This includes studies on the metal-water reaction, the

hydrogen generation involved, and the permeation of the hydrogen into the primary circuit. Permeating hydrogen can cause oxide film reduction on the primary side of the tubes and decarburization of the material. Other phenomena of interest are the possible deposition of carbon and/or the carburization of the steel by the small amounts of carbon monoxide present in the inert helium, used as coolant gas. In addition, the hydrogen permeation under low partial pressures was investigated. The hydrogen release rates (due to the metal-water reaction) were determined for several types of steels for different temperatures. The results served as a basis for an estimate of the hydrogen delivery from the secondary circuit into the primary circuit and its influence on the required gas purification capacity. An attempt is made to explain the irregularities of the hydrogen release rates observed. It appears that the carburization problem is not of major significance under the low carbon monoxide concentrations that must be expected in the coolant under normal operation conditions.

56432 Cylindrical prestressed concrete tank for a nuclear power plant. Horner, M.; Hodzic, A.; Haferkamp, D. (to Hochtemperatur-Reaktorbau GmbH). US Patent 4,032,402. 28 Jun 1977. Filed date 4 May 1976. 10p.

A cylindrically shaped prestressed concrete tank for a gas-cooled high temperature nuclear reactor plant includes a centrally located chamber for the reactor with a number of horizontally extending compartments located below the reactor chamber and at least two different groups of vertically extending compartments located radially outwardly from reactor chamber. The tank is prestressed by vertically extending tensioning elements and two different groups of horizontally extending tensioning elements. One group of horizontally extending tensioning elements extend chordally alongside and for the vertical range of the horizontal compartments and are anchored on the outer surfaces of the tank. The other group of horizontal tensioning elements are ring-shaped and extend in channels around the outer surface of the tank. This other group is located above and below the vertical range of the horizontal compartments. 13 claims, 5 figures.

56433 Transient behavior of HTGR fuel particles. Mortenson, S.C.; Okrent, D. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **26**: 169(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56434 Resource utilization of symbiotic HTGR systems. Borgonovi, G.M.; Brogli, R.H. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **26**: 282(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56435 Distribution of cesium and other fission products in Peach Bottom HTGR fuel elements. Wichner, R.P.; Dyer, F.F.; Malinauskas, A.P. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 313-314(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56436 Study of radionuclides in the Peach Bottom HTGR primary circuit. Dyer, F.F.; Wichner, R.P.; Malinauskas, A.P. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 314(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56437 HTGR offers chance to stretch fuel reserves. *Energy Int.;* **14**: No. 5, 25-28(May 1977).

Economic factors associated with the thorium fuel cycle which might influence a utility's decision to adopt HTGR over LWR systems are discussed.

56438 Europe pushes direct cycle development. Schmidt, D. (Brown Boveri and Co. Ltd., Baden, Switzerland). *Energy Int.;* **14**: No. 5, 33-35(May 1977).

Efforts to develop a direct cycle gas turbine for HTGR systems are discussed.

56439 Design of turbomachinery for the gas turbine (direct cycle) high temperature gas cooled reactor power plant. Adams, R.G.; Boenig, F.H. (Gen At Co, San Diego, Calif). *Am. Soc. Mech. Eng., [Pap.]:* No. 77-GT-38, 1-17(27 Mar 1977).

Previous papers have described configuration studies leading to the selection of reactor and power conversion loop layout, and the considerations affecting the design of the components of the power conversion loop. This paper discusses briefly the effects of the helium working fluid and the reactor cooling loop environment on the design requirements of the direct-cycle turbomachinery and describes the mechanical arrangement of a typical turbomachine for this application. The aerodynamic design is outlined, and the mechanical design is described in some detail, with particular emphasis on the bearings and seals for the turbomachine. 11 refs.

56440 Ammonia turbomachinery design considerations for the direct cycle nuclear gas turbine waste heat power plant. McDonald, C.F.; Vepa, K. (Gen At Co, San Diego, Calif). *Am. Soc. Mech. Eng., [Pap.]:* No. 77-GT-75, 1-21(27 Mar 1977).

This paper describes the turbomachinery design considerations for a supercritical Rankine cycle waste heat power conversion system for use with the large helium closed-cycle gas turbine nuclear power plant under development by General Atomic Company. The conceptual designs of the ammonia turbine and pump are presented. The high density working fluid in the ammonia turbine results in small blade heights and high hub-to-tip ratios due to a combination of the properties of ammonia and the high degree of pressurization, particularly at the turbine exit. With the molecular weight of the ammonia working fluid being very similar to steam, the double-flow, multistage axial ammonia turbine bears a strong resemblance to modern steam turbines. 23 refs.

56441 Behaviour of tritium in a graphite reactor. Fischer, P.G.; Hecker, R.; Roehrig, H.D.; Stoever, D. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). *J. Nucl. Mater.;* **64**: No. 3, 281-288(Feb 1977). (In German).

An experimental investigation of the behaviour of tritium and hydrogen in HTR graphites is described. The diffusion and adsorption kinetic isotherms were measured using a specially developed vacuum apparatus with a variable temperature/time function. Hydrogen was estimated using a mass spectrometer. Tritium was analysed quantitatively after catalytic oxidation using a liquid scintillator. The diffusion coefficients for tritium in reactor graphite were found to be as follows: D=0.024 cm/²sec exp(-2.78 eV/kT) and the desorption energies Esub(des)sup(I) = 1.38+-0.07 eV, Esub(des)sup(II)=2.07+-0.13 eV, Esub(des)sup(III)=3.27+-0.07 eV. The results indicated that the actual tritium inventory is largely determined by the buffering action of the graphite core. In the start-up phase of an HTR, the tritium concentration in the coolant gas remains low, despite an increased rate of production because the tritium is being adsorbed by the graphite. In later stages of operation, after equilibrium has been reached, the tritium level will be supplemented by material from the hot core regions, so that the coolant activity is not determined by the production rate alone.

56442 HTR near-breeder concept as a means of saving fissile material. Schulten, R.; Teuchert, E.; Ruetten, H.J. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). *Atomwirtsch., Atomtech.;* **22**: No. 2, 92-96(Feb 1977). (In German).

5 figs.; 2 tabs.; 10 refs.

Computer codes for the long-time consumption of fissile material depending on reactor strategies permit optimizing studies for fuel management. An interesting example for this is a fuel cycle system with an HTR near-breeder concept consisting of a combination of two variants of the pebble bed reactor with different fuel element loading. By comparing six different reactor strategies based on a forecast for the need of electricity in the DeBeNeLux countries it is shown that the accumulated need of U_3O_8 for this near-breeder system lies considerably lower than with other thermal reactors.

56443 Cooling of nuclear power plants equipped with high-temperature reactors and helium turbine cycles. Foerster, S.; Hewing, G. (Kernforschungsanlage Juelich, Ger.). *VGB Kraftwerkstech.;* **57**: No. 2, 95-106(Feb 1977). (In German).

In nuclear power plants with high temperature reactors and helium turbine cycles (HTR-single circuits) the residual heat from the energy conversion process in the primary and intermediate coolers must be removed from the cycled gas, helium. Water, which is circulated for safety reasons through a closed circuit, is used for cooling. The primary and intermediate coolers, as well as other cooling equipment of the power plant, are installed within the reactor building. The heat from the helium turbine draft cycle is removed to the environment most effectively by natural draft cooling towers. In this way a net plant efficiency of about 40% is attainable. The low quantities of residual heat thereby produced and the high (in comparison with power stations with steam turbine cycles) cooling agent pressure and cooling water reheat pressure in the circulating coolers allow an economically favorable design of the entire cold end to be achieved. In the so-called unit range it is possible to make do with one or two dry cooling towers. Known techniques and existing operating experience can be used for these dry cooling towers. Afterheat removal following reactor shutdown is effected by a separate, redundant cooling system with forced-air dry coolers. The heat from the cooling process at other locations in the power plant is removed to the environment either by a forced-air dry cooling installation or by a wet cooling system. 10 refs.

56444 Gas-cooled nuclear reactor with a pressure vessel with liners. Bachl, H. (to Kraftwerk Union A.G., Muelheim an der Ruhr

(Germany, F.R.)). German(FRG) Patent 2,342,262/C/. 13 Jan 1977. 3p. (In German).

2 figs.

The claim relates to the lining of the pressure vessel with at least 2 liners, one lying in the other and partially gas-cooled. The liners are cooled by a bypass flow of the reactor coolant gasflowing through in the sequence of their arrangement. The coolant bypass flows enter the outer liner with a temperature below 0°C. The coldness required is produced from waste heat in an absorption plant. The heated bypass flows emanating from the inner liner are added to the main gas flow entering the reactor. In the case of breakdown of the operating pressure in the reactor, at least one bypass flow is switchable to an auxiliary coolant, e.g. water.

56445 Graphite reflector in HTR with pebble bed and OTTO-fueling. Kasper, K. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Nukleare Sicherheitsforschung); Petersen, K. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). *Atomkernenergie;* **29**: No. 2, 123-127(1977). (In German).

From Technical meeting on radiation exposure and damage of reactor components outside the reactor core; Stuttgart, Germany, F.R. (23 Sep 1976).

9 figs.; 8 refs.

Because of the locally raised power density the graphite reflector immediately surrounding the pebble bed has a higher fast neutron dose. Therefore the neutron-induced dimensional changes (shrinkage with subsequent growth) with their turnaround point governed by the prevailing temperature have to be regarded carefully. Simple and easy-to-realize measures are suggested which provide a cold bypass gas stream in gaps between blocks, thereby lowering the graphite temperatures. Additionally a stress analysis with finite element codes has been carried out, the results of which confirm that these cooling measures reduce the reflector block stresses reasonably. Taking very conservative stress criteria the limiting tensile strength of the graphite is not reached in the time period considered. This allows a lifetime layout of the reflector which is supported by its possible removability as a back-up solution in case of unexpected material behaviour, this also helping to weaken the argument of inadequate operating experience.

56446 Kernel migration for HTGR fuels from the system Th-U-Pu-C-O-N. Lindemer, T.B.; Pearson, R.L. (Oak Ridge Natl Lab, Tenn). *J. Am. Ceram. Soc.;* **60**: No. 1/2, 5-14(1977).

Nuclear fuels for the high-temperature gas-cooled reactor (HTGR) consist of spherical kernels of actinide compounds contained in gastight pyrolytic carbon and SiC. The fuel kernels migrate up the temperature gradient and into the coating layers. A theoretical analysis of in-reactor migration data indicates that a solid-state diffusion process controls the migration rate in fissioned particles. This phenomenon may limit fuel performance. 49 refs.

56447 Nuclear gas turbine power plant activities in the United States. McDonald, C.F.; Krase, J.M. (Gen At Co, San Diego, CA). *Sawyer's Gas Turbine Int.;* **18**: No. 2, 10-14(1977).

A summary is given of the design concept for a large direct cycle high temperature gas-cooled reactor plant. A nuclear gas turbine power plant design and RandD program supported by the German and Swiss governments is underway with participation by industrial and laboratory organizations. A cooperation has been established between the U.S. AT-HTGR program and the European HHT program. A brief outline of the HHT program and of the GA-HHT cooperation is included. 7 refs.

56448 Air supplants water at Schmehausen. Seyser, E. *Welt (Hamburg);* No. 287, 6(Dec 1976). (In German).

1 fig.

Advantages and shortcomings of present cooling methods to discharge waste heat from power plants are described. The dry cooling tower is said to be the best solution. The technical requirements are discussed by the example of the Schmehausen cable net cooling tower.

56449 Schmehausen cable net cooling tower. Schlaich, J.; Mayr, G. (Leonhardt und Andrae, Stuttgart (Germany, F.R.)); Weber, P.; Jasch, E. (Krupp (Friedr.) G.m.b.H., Goddelau (Germany, F.R.). Industrie und Stahlbau). *Bauingenieur;* **51**: No. 11, 401-412(Nov 1976). (In German).

23 figs.; 7 refs.

The prototype of a large cable net shell as a natural-draught cooling tower for the THTR-300 is presented. Results of wind tunnel tests and calculations are given, and the capacity is discussed. Design features of the main components are presented in illustrations and are described with regard to the construction process of the cooling tower. It is shown that the cable net cooling tower is a suitable construction for large dimensions and caving-in or seismic areas.

56450 Mathematical model to analyze the effect of properties of the working media on principal technical and economic indices of nuclear gas turbine plants. Tetel'baum, S.D. (Odessa Polytech Inst, Ukr SSR). *Teploenergetika (Moscow);* No. 9, 66-69(Sep 1976). (In Russian).

A mathematical model is presented for an analysis of the effect of the properties of the working media on the main performance characteristics of closed-loop nuclear gas turbine plants. This model permits comparison and selection of the most effective working media.

56451 Mixing of particles in a spouted bed. Takeda, H.; Yamamoto, Y. (Tokyo Univ. (Japan). Faculty of Engineering). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 7, 372-381(Jul 1976).

For analyzing the mixing of particles in a spouted bed, a model is proposed, which assumes that: (a) the spouted bed consists of a spout part characterized by perfect mixing and an annulus part occupied by piston flow, (b) the ingress of particles from annulus into spout takes place within a zone below a depth h below the top of the annulus, and (c) the rate of ingress of particles into the spout is constant throughout the bed. The time-dependence of the concentration $C^*(t)$ of marked particles within the spout can be calculated with this model assuming suitable values for unmeasurable parameters. The value of $C^*(t)$ was measured from mixing experiments undertaken using alumina particles, to which a small batch of marked alumina particles was dropped transiently onto the bed in stable operation. Comparing the experimental data with the calculated results, it was found that: (a) the mixing of particles in the bed can be satisfactorily described with this model, provided that a suitable correction is added to the quantity of particles present in the spout to account for the existence of mixing in the annulus, whereas the model assumed piston flow; (b) the upper edge of the ingress zone of particles from the spout into the annulus is located in the conical part of the bed. Increasing the flow rate of spouting air shortened the cycle time of particles, while the mixing rate within one cycle was not affected to any significant extent by changes in flow rate.

56452 Spherical fuel element for high temperature reactors. Rachor, L. (to Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). German(FRG) Patent 1,514,292/B/. 16 Jun 1976. 3p. (In German).

2 figs.

The proposal deals with spherical fuel elements for high temperature power reactors in which the fission or breeder material is arranged in loose bulk in the form of coated particles in the cavities of a spherical graphite body. Such spherical fuel elements formed of 2 parts do not have a good mechanical resistance. According to the invention, it is suggested to design the two conical cavities lying inside the graphite sphere with processing openings closed by stoppers, through which the fission or breeder material is introduced.

56453 Test or measuring sphere for nuclear reactors with spherical fuel elements. Schweiger, F.; Fritzsche, W. (to Hochtemperatur-Kernkraftwerk G.m.b.H. (HKG), Uentrop (Germany, F.R.)). German(FRG) Patent 2,315,847/B/. 10 Jun 1976. 3p. (In German).

The invention deals with a test sphere to be used for the control of the flow behaviour of the spherical fuel elements of a gas-cooled high-temperature nuclear reactor. As the test spheres are to be identified using an electromagnetic measuring device the test spheres are lined or coated according to the invention with conductive material which increases the electrical conductivity of the test sphere compared to the spherical fuel elements. The coating can consist of a continuous, interrupted or net-like layer. The method of coating the layer of a good conducting material involves that the material be separated off chemically from the vapour phase, chemically without current or electrolytically.

56454 Gas-cooled, graphite-moderated nuclear reactor. Butterfield, C.E.; Haake, N. (to UKAEA London Office). German(FRG) Patent 1,614,916/B/. 13 May 1976. 3p. (In German).

2 figs.

Modern gas-cooled, graphite-moderated nuclear reactors of the AGR type possess an access pipe for fueling for each fuel element channel, which protrudes out through the concrete container. It is difficult to install the pipes standing very close to each other which are constructed of part pieces welded together. It is therefore suggested to modify the standpipes at the place where they jut out of the wall, so that they can be more easily connected to the upper plate and to each other. Each standpipe is fixed at least to one other standpipe in such a way that an axial movement between them is counteracted.

56455 Metallurgical problems of the he-to-he heat exchanger for advanced htr's. Huddle, R.A.U.; Fricker, H.W. (Comm of the Eur Community, JRC, Neth). *Rev. Int. Hautes Temp. Refract.;* **13**: No. 4, 212-316(1976).

The article discusses the feasibility and design criteria of an intermediate high-integrity 3,000 MW (th) gas/gas heat exchanger

operating as part of the primary circuit of a nuclear plant. The basic principles involved in the heat exchanger concept are described, and the metallurgical requirements are dealt with. 5 refs.

56456 Aluminum as construction material for cooling towers. Spaelti, E.; Kehler, W.F. (Schweiz Alum, Zurich). *Schweiz. Alum. Rundsch.;* 26: No. 6, 248-252(1976). (In German).

For a new 300 MW nuclear power plant currently under construction in the Federal Republic of Germany using a helium-cooled thorium high-temperature reactor, a cooling system operating with a dry cooling tower of a special design has been devised. The tower has a parabolic shape, is 181 M high, and consists of a load-bearing, reinforced concrete pylon 7 m in diameter supporting a cable net wall structure to which 37,000 sq m AlMn alloy sheeting is attached. The mode of operation of this cooling system is explained.

56457 Preparation of fuel elements for high temperature gas cooled reactors. Bradley, R.A.; Sease, J.D. (to Energy Research and Development Administration, Washington, D.C. (USA)). French Patent 2,293,037/A/. 26 Nov 1975. 6p. (In French).

Priority claim: 26 Nov 1974, US.

A description is given of an improved process for the fabrication of nuclear fuel composites, the characteristic being that several 'green' compressed masses are heated, each mass being composed of dispersed microspheres of nuclear fuel as oxide or carbide covered with pyrolytic carbon in a pitch matrix. The agglomerates are enclosed in various graphite tubes which are then enclosed in an autoclave and heated to a temperature ranging between 700 and 1000 deg C under an isostatic pressure of between 350 and 1050 kgf/cm^2 long enough to carbonize the pitch. The carbonized agglomerates are then cooled at room temperature.

56458 Method for urgently cooling a core in high temperature gas reactor. Tanaka, Y. (to Kawasaki Heavy Industries Ltd., Kobe (Japan)). Japanese Patent 1976-98,499/A/. 25 Feb 1975. 6p. (In Japanese).

Object: To bring the interior of a reactor vessel into communication with the lower gas prenum in a manner so as to be opened only in case of emergency at the lower end of core structure to form a natural convection circulation cooling system when forced convection circulation cooling system is inoperable, thereby preventing the core structure or the like from being damaged. Structure: In case of emergency, (1) the gas flow passage in the core is brought into communication with the gas flow passage in the reactor vessel at the bottom of the core so that heat in the core is transmitted to the reactor vessel by natural circulation of gases within the system; and (2) refrigerant is supplied to an indirect cooling layer disposed between the reactor vessel and the biological shield so that the heat transmitted from the reactor vessel to the indirect cooling layer by means of natural circulation is carried out of the system by means of natural circulation of the refrigerant.

56459 Low temperature steam generator. Faugeras, P.; Lecocq, A. (CEA, 75 - Paris (France)); Romet, J.-L. (Societe d'Etudes Chimiques, 92 - Bourg-la-Reine (France)). (to CEA, 75 - Paris (France)). French Patent 2,296,923/A/. 3 Jan 1975. 7p. (In French).

The steam generator described has a molten salt nuclear reactor and a fluidized bed exchanger inside the same containment, located over the reactor core at a point in its molten salt state. The molten salts flow through the primary pipes and the water through the secondary pipes from which it emerges as steam. The two sets of pipes bathe in a bed of particles stirred by an inert gas current. The molten salt, circulating by thermo-convection is a mixture of lithium, beryllium, uranium and thorium fluorides. The fluidized bed is made of graphite balls and the inert gas current is helium. The intake and outlet temperatures in the molten salt mixture exchanger are around 700 deg C and 500 deg C respectively, and the intake water and steam outlet temperatures around 90 deg C and 300 deg C respectively.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 56606

56460 CANDU fuel: power ramp performance criteria. Penn, W.J. (Canadian General Electric Co., Peterborough, Ont.); Lo, R.K.; Wood, J.C. *Nucl. Technol.;* 34: No. 2, 249-268(Jul 1977).

Extensive fuel performance data obtained from Canadian Deuterium Uranium (CANDU) power reactors and experimental reactors are analyzed. Various modes of power ramping that cause fuel defects are identified, and fuel defect criteria are derived. The probability of a defect occurring in a power ramp is found to depend on the magnitude of the ramped power, the power increase, the fuel burnup, and the time fuel dwells at the ramped power. Physical interpretations are offered in terms of mechanisms believed to account for power ramp defects. The dominant mechanism is considered to be stress corrosion cracking of the Zircaloy clad, induced by the release of such fission products as iodine from the fuel.

56461 Heavy water reactor best option for technology transfer. Guard, R.F.W. (Canatom Ltd., Montreal). *Energy Int.;* 14: No. 5, 17-19(May 1977).

It is suggested that the CANDU system is the only nuclear concept that will allow a developing country to obtain a capability in the manufacture of its own nuclear power plants. Reasons for this are discussed.

56462 Future routes for Canada's nuclear effort. *Energy Int.;* 14: No. 5, 20-22, 40(May 1977).

Studies being pursued to adapt the CANDU reactor concept to new fuel cycles are described.

56463 Steam generating heavy water reactor: design and operational experience. Smith, D.R. *Energiespectrum;* 1: No. 2, 47-56(Feb 1977).

The article surveys the design and operational experience of the commercial SGHWR (CSGHWR) reactor which is based on the Winfreth SGHWR reactor. The main parameters are given. A brief discussion of the fuel cycle, reactor control, emergency shutdown, plant radiation levels and safety features is presented. The layout and containment of the reactor is discussed with emphasis on the CSGHWR fuel stringer and the experience gained with the Winfreth reactor. Finally, attention is paid to core vessels and the reactor coolant circuit.

56464 Compressibility and compliance of spiral wound gaskets. Bazergui, A. (Ecole Polytechnique, Montreal). pp 183-191 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

Asbestos-filled spiral-wound stainless steel gaskets are used almost exclusively in pressure retaining components for CANDU type reactors. The purpose of the paper is to report on a series of compression tests on spiral wound gaskets ranging in diameter from approximately 1 in. (25 mm) to 50 in. (1270 mm). It is shown that much higher stresses than stated in the ASME Code are necessary to properly compress the gaskets to the manufacturer's recommended value. The stress is found to be related to gasket compressive strain and to the number of spiral windings per unit width of gasket (winding density). In addition, a high gasket decompression modulus is observed which explains why a gasket relaxation of the order of 0.003 in. (0.08 mm) is sufficient to cause an important drop in the compressive stress. A relation between gasket decompression modulus, maximum applied stress and winding density is suggested. The effect of the results on the design of bolted flange connections and in particular that of double gasketed joints (a compulsory feature in Canadian nuclear applications) is discussed.

56465 Finite element analysis of reactor support diaphragm for elastic instability. Dixit, K.B.; Nandakumar, S.; Patwardhan, V.M. (Dept. of Atomic Energy, Bombay). pp 323-328 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

The reactor support diaphragms analysed for elastic instability in the paper are thin annular plates supporting a horizontal cylindrical nuclear reactor vessel with integral end shields. The annular support diaphragms are subjected to in-plane loads due to radial thermal expansion and the dead weight of the reactor vessel as well as some other transverse loads including an earthquake load. The annular support diaphragms are designed in accordance with the requirements of ASME Boiler and Pressure Vessel Code Section III, Subsection NF, Component Supports. The inplane loadings are compressive in nature and therefore it is necessary to examine the elastic instability of the support diaphragm to satisfy the code requirements.

56466 Outline of manufacturing and installation experience of pressure vessel structure for the prototype heavy water moderated, boiling light water cooled reactor FUGEN. Shibato, E. (Hitachi, Ltd., Ibaraki, Japan); Koyama, T.; Oguchi, I.; Morisawa, J.; Akebi, M. pp 907-913 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

The Prototype Heavy Water Moderated, Boiling Light Water Cooled Reactor FUGEN, which is now under development in Japan, is at the final stage of construction and is expected to reach its first criticality in early 1978. The reactor structure of FUGEN, which mainly consists of pressure tube assemblies, a calandria,

thermal shields, and inlet and outlet feeder pipes, is completely different from those of conventional BWRs or PWRs. The fabrication, inspection and testing, and installation work for FUGEN was carried out successfully. The paper briefly describes the fabrication, test and inspection, and installation of the pressure vessel structure of FUGEN.

56467 Fuel element for heavy water moderated nuclear reactors. Lettau, H.; Kroepfl, H.; Knoedler, D. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,019,271/C/. 26 May 1976. 5p. (In German). 8 figs.

The invention deals with fuel elements for heavy water moderated nuclear reactors consisting of a fuel rod bundle which is arranged in circular geometry parallel to one another. Separating tubes contain the exchangeable fuel rods flowed around by coolant. It is suggested to fill up the whole available length of the separating tube with fuel. In order to then exclude that the several meters long fuel element vibrates due to the coolant flow, improvements have been designed for the spacers arranged on top of one another in cross-sectional planes. These consist of a solid grid of high-edge arranged ridger. The equipment is described by means of a nuclear reactor type corresponding to the multi-purpose research reactor in Karlsruhe.

56468 Development on the refueling machine for prototype advanced thermal reactor 'Fugen'. Kubota, S. (Fuji Electric Co. Ltd., Kawasaki, Kanagawa (Japan). Kawasaki Factory). *Fuji Jiho;* **49**: No. 5, 250-258(May 1976). (In Japanese).

The trial fabrication of a full scale refueling machine for Fugen was completed at the Fuji Electric Co. under the contract with the Power Reactor and Nuclear Fuel Development Corporation (PNC). The design and the technological development of the machine are reviewed together with the results of various operation tests. The first part of the report generally explains the refueling system of "Fugen". The second part describes the outline of the refueling machine. The mechanical structure and the main specifications of the refueling machine are shown. Special emphasis is duly placed on the ability of refueling during loading and the corresponding mechanism. The third part explains the trial fabrication and the development of the main components of the refueling machine and presents the results of various tests. Those tests were generally performed under actual operational conditions, namely, the coolant temperature of 277°C, the pressure of 72 kg/cm², and the flow rate of 40 m³/h. The developmental history and the results of the tests are shown.

56469 Physics calculations of A-1 type heavy water reactors. Rocek, J.; Miasnikov, A. *Nukleon;* No. 4, 22-28(Mar 1976). (In Czech).

The flow chart is given of the physics calculation of a heavy water reactor and its respective blocks are described. The methods and programmes of calculation developed during the A-1 power plant construction are outlined. The results are assessed which were obtained in correlating the A-1 theory and experiment. The results interesting for practical applications in reactor operation are indicated, such as compensation optimization or the temporal distribution of burn-up during reactor operation.

56470 Delayed hydrogen cracking of zirconium alloy pressure tubes. Jackman, A.H.; Dunn, J.T. Chalk River, Ont.; Atomic Energy of Canada Ltd. (1976). 19p.

After several years of almost continuous service, Pickering Reactor Units 3 and 4 have both experienced long outages to replace cracked pressure tubes. This report summarizes the status of the investigation into the cause of the cracks as of May 1976. The basic cause of the cracking was the presence of very high residual tensile stresses in the pressure tubes due to improper rolling procedures. These residual stresses are now being reduced to acceptable levels by local stress relieving techniques.

56471 Pressure tube reactor. Suzuki, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-108,192/A/. 19 Mar 1975. 4p. (In Japanese).

Object: To readily install and replace a pressure tube assembly and to simplify a reactor supporting concrete structure and piping structure. Structure: An adiabatic gas tank and a cooling tank are provided at the lower part of a core, and the adiabatic gas is supplied from the adiabatic gas tank to a clearance formed between the pressure tube assembly and a pipe line surrounding the outer periphery thereof and the coolant is supplied from the cooling tank to the pressure tube assembly to remove the pressure tube assembly from the core.

56472 Core construction in a pressure tube type heavy water reactor. Ueda, M.; Aoki, K. (to Nippon Atomic Industry Group Co. Ltd., Tokyo). Japanese Patent 1976-101,687/A/. 5 Mar 1975. 5p. (In Japanese).

Object: To replace a centrally positioned fuel assembly of a fuel assembly unit with reactor controlling machinery to decrease a distance between the fuel assemblies thereby saving use of heavy water and enhancing economy. Structure: A centrally positioned fuel assembly of a fuel assembly unit, which is composed of a plurality of fuel assemblies orderly arranged in lattice fashion, is replaced with a reactor controlling members such as control rods, poison tubes and the like to provide an arrangement of lattice-free type fuel assembly, thus reducing the pitch as small as possible.

56473 End face seals in high pressure water--learning from those failures. Metcalfe, R. Chalk River, Ont.; Atomic Energy of Canada Ltd. (1975). 11p.

The experience gained in the operation of end face seals for large primary heat transport pumps, which circulate hot pressurized water around and through the cores of nuclear reactors, is summarized. A number of examples of seal failure from Canadian nuclear experience are described, including failures due to inadequate lapping, inelasticity, erosion, corrosion, abrasion, adhesion, surface fatigue, cavitation, thermocracking, seal ring breakage, and static seal failure. 11 refs.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 56390, 56723, 56724, 56725, 56726, 56768, 56771, 56772, 56774, 56775, 56776, 56777, 56778, 56784, 56788, 56794, 56801, 56816, 56817, 56818, 56819, 56820, 56821, 56822, 56823, 56824, 56825, 56826, 56827, 56828, 56829, 56830, 56831, 56832, 56833, 56834, 56835, 56836, 56838, 56839, 56840, 56841, 56842, 56843, 56844, 56845, 56846, 56848, 56849, 56850, 56851, 56852, 56853, 56854, 56855, 56856, 56857, 56878, 57112

56474 (AEEW-R—1090) Actinide fission rate measurements in Zebra. Sweet, D.W. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Jan 1977. 24p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Fission rates in U-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Am-243 and Cm-244 have been measured at the center of Zebra Core 14 where the neutron energy spectrum was similar to that of the Prototype Fast Reactor. The experimental values are compared with those predicted by the FGL5 cross-section library.

56475 (ANL—8067) Postirradiation examinations of the BG-9 element. Strain, R.V.; Renfro, C.W.; Neimark, L.A. (Argonne National Lab., Ill. (USA)). Oct 1976. Contract W-31-109-ENG-38. 56p. Dep. NTIS, PC A04/MF A01.

Postirradiation examinations were performed on the GB-9 element irradiated in the Oak Ridge Reactor. This vented fuel element was irradiated to a peak burnup of 54,000 MWd/MT at a peak power rating of 14.8 kW/ft and a maximum outside surface temperature of 685 +- 15°C. The maximum diametral increase of the element was 0.2% ΔD/D. Volatile fission products migrated to the ends of the fuel column but had not been transported beyond the blanket region of the element. Fission-product attack of the cladding was found to a depth of 4.4 mils adjacent to the mixed-oxide fuel. The maximum fission-product attack (approximately 6.2 mils) was found adjacent to slightly hyperstoichiometric UO_2 pellets at the upper end of the fuel column. The more severe attack in this region has been attributed to the higher oxygen potential adjacent to the hyperstoichiometric UO_2 fuel. A stress-rupture test was performed on a section of the element. The cladding ruptured after 30 min at 700°C and approximately 21,500-psi loop stress, resulting in a diametral strain of 1.6%.

56476 (ANL-CT—77-30) Detection of a partial blockage in a heterogeneous core. Howard, P.A. (Argonne National Lab., Ill. (USA)). Jul 1977. Contract W-31-109-ENG-38. 46p. .

Experiments were conducted to assess the instrumentation accuracy of a heterogeneous core configuration of a LMFBR for both normal full-power full-flow conditions and the unusual condition of a partial assembly blockage. Instrument post accuracy was studied for three fuel assemblies and three blanket assemblies. Steady-state simulation tests were conducted at 1/10-scale where water was used as a test fluid. A total of 367 assemblies were simulated; fuel, inner blanket, outer blanket and control assemblies were modeled. A lower flowrate limit at which accurate measurements were possible was found for both fuel and inner blanket assemblies. Data were recorded for simulated assembly flowrates as low as 15% of normal flow.

56477 (CONF-760503—P1) Proceedings of the international conference on liquid metal technology in energy production. Cooper, M.H. (ed.). (American Nuclear Society, Hinsdale, Ill.; American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc., New York; Energy Research and Development Administration, Washington, D.C. (USA); American Nuclear Society, Pittsburgh, Pa. Pittsburgh Section). Nov 1976. 468p. Dep. NTIS $12.00.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

Each paper in the volume has been separately abstracted and indexed. (DG)

56478 (CONF-760503—P1, pp 1-11) **Some aspects of sodium technology issued from the operating experience of RAPSODIE and PHENIX.** Kremser, J. (CEA, Cadarache, France); Lacroix, A. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

This paper deals with the experience on sodium technology gained from RAPSODIE and PHENIX operation. Problems encountered with sodium circuits, main components, handling equipment and instrumentation are discussed. Some information related to the contamination by radioactive products of sodium and sodium circuits is given.

56479 (CONF-760503—P1, pp 12-21) **Sodium technology at EBR-II.** Holmes, J.T.; Smith, C.R.F.; Olson, W.H. (Argonne National Lab., Idaho Falls, ID). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Since the installation of purity monitoring systems in 1967, the control of the purity of the primary and secondary sodium and cover gas systems at the Experimental Breeder Reactor II (EBR-II) has been excellent. A rigorous monitoring program is being used to assure that operating limits for more than 25 chemical and radioactive impurities are not exceeded. The program involves the use of sophisticated sampling and analysis techniques and on-line monitors for both sodium and cover gas systems. Sodium purity control is accomplished by essentially continuous cold trapping of a small side stream of the total circulating sodium. The cold traps have been found to be very effective for the removal of the major chemical impurities (oxygen and hydrogen) and tritium but are almost ineffective for ^{131}I and ^{137}Cs that enter the sodium from fuel cladding breaks. Purging with pure argon maintains the cover gas purity.

56480 (CONF-760503—P1, pp 22-29) **Impurity deposition in PFR plugging meters and cold traps.** Allan, C.G. (Dounreay Experimental Reactor Establishment, Scotland). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Plugging meter and cold trap performance were examined during the initial cleanup of the PFR primary circuit. The kinetics of impurity deposition in the plugging meters were analyzed, and showed second order dependence on concentration driving force or supersaturation. The analysis suggested that oxide was the fast plugging species when multiple plugging breaks were present, and this was consistent with the results of an extensive analysis of the composition and distribution of the deposits in the exhausted PFR cold trap. Oxide was the major impurity present in the trap, with approximately equal quantities of hydride and hydroxide. Most of the impurities (70% by weight) had deposited in the first 40—110 mm of mesh depth, with deposit build-up to a depth 45—70 mm upstream of the mesh. The oxide, hydride and hydroxide contents of the local deposits were highest near the trap inlet, in the sludge deposit in the bottom of the vessel, and in the mesh, respectively.

56481 (CONF-760503—P1, pp 30-34) **Radioactive product behavior during the operation of sodium-cooled reactors of the USSR.** Krasnoyarov, N.V.; Polyakov, V.I.; Chechetkin, Yu.V. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Results concerning fission and corrosion product behavior at BR-5 and BOR-60 are discussed. A conclusion about the limited feasibility of sodium-cooled reactor operation with failed fuel pins has been drawn. The permissible number of failed pins is defined by both the capability for coolant decontamination from fission products and the radioactivity level during maintenance.

56482 (CONF-760503—P1, pp 35-43) **Activity deposition in DFR primary cold traps.** Allan, C.G.; Taylor, T.A.H. (Dounreay Experimental Reactor Establishment, Scotland). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The deposition of fission products and other impurities in 5 DFR primary circuit cold traps has been measured. Steam cleaning and acid pickling was used to remove the activity, and the decontamination liquors were analyzed by high resolution gamma spectrometry. Direct gamma spectrometry of two of the baskets at different stages of the decontamination considerably increased the value of the results. It enabled the distribution of the individual nuclides to be measured in the traps, and gave decontamination efficiencies for each decontamination stage. 131-I collected in the traps by filtration cold trapping, but was easily removed by steam cleaning. 137-Cs collected by adsorption on the steel surfaces of the trap, and deep surface penetration made its removal extremely difficult. 137-Cs will therefore cause difficulties in the maintenance of fast reactor components. /sup 129m/Te also collected in the trap and required an acid pickle for its removal. 125-Sb appeared to be associated with small amounts of particulate fuel collected by the trap. Surface penetration by /sup 129m/Te, ^{125}Sb and other fission products did not occur.

56483 (CONF-760503—P1, pp 44-50) **Tube tightness survey during Phenix steam generator operation.** Cambillard, E. (CEA/CEN, de Saclay, Gif-sur-Yvette, France). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Phenix steam generators are once-through vessels with single-wall heat-exchange tubes. This design means that any leakage of water into the sodium must be detected as quickly as possible so that the installation can be shut down before extensive damage occurs. The detection of water leaks in Phenix steam generators is based on measurement of the concentration in the sodium, of hydrogen produced by the sodium-water reaction. Since the various modules—evaporators, superheaters, and reheaters—have no free sodium surfaces, detection of hydrogen in argon is not used in Phenix steam generators. The measurement systems employ a probe made of nickel tubes 0.3 mm thick. Hydrogen in the sodium diffuses into a chamber kept under vacuum by an ion pump. The hydrogen pressure in the chamber is measured by a quadrupole mass spectrometer. The nine measurement systems (three per steam generator) are calibrated by injecting hydrogen into the sodium of the secondary circuits. The data-processing computer calculates the hydrogen concentration in the sodium from the spectrometer signals and the probe temperatures, which are not regulated in Phenix; it generates instructions that enable the operator to act if a leak appears. So far, no leaks have been detected. These systems also make it possible to determine rates of hydrogen diffusion caused by corrosion of the steel walls on the water side.

56484 (CONF-760503—P1, pp 51-59) **Evolution of sodium purification: RAPSODIE, PHENIX, SUPER-PHENIX.** Abramson, R. (CEA, Cadarache, France); Elie, X.; Saur, J.M.; Thevenin, M.; Velin, F. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Fast reactors require large quantities of sodium. In order to reduce the initial purification period, special precautions are taken during fabrication, assembly, and the filling of storage facilities and tanks. The operating experience acquired with RAPSODIE and PHENIX has enabled a good definition to be obtained of permanent purification features for future reactors.

56485 (CONF-760503—P1, pp 60-66) **Metallurgical problems associated with large sodium loop operations.** Hoffman, N.J. (Liquid Metal Engineering Center, Canoga Park, CA). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Sodium loops have had many years of successful operation throughout the world. There are certain phenomena occurring during operation of these loops that are of interest to the metallurgist. A number of these phenomena are discussed in terms of problems and their solutions. The problems are discussed in the areas of cleaning and refilling of a loop, friction, mass transfer, aging effects, energy transfer, and metallurgical aspects in loop design, construction, and maintenance.

56486 (CONF-760503—P1, pp 67-74) **Materials experience with large sodium loops and components.** Mausbeck, H. (Interatom, Bensburg, Ger.). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The properties of sodium as a heat transfer fluid for fast reactors influence the design of the system components. Examples of the properties to be discussed are the affinity of sodium for oxygen and water, and the physical characteristics which lead to the sodium frost phenomena and impurity solubility.

56487 (CONF-760503—P1, pp 75-82) **Experience with sodium purification on large-scale operational test loops in France.** Benoist, E. (CEA, Cadarache, France); Cambillard, M.; Quinet, J.L. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

After a discussion of the major characteristics of four large test loops operational in France, the paper reviews the sodium purification equipment used in conjunction with these test facilities, the purification monitoring devices and operational procedures. Operating experience is also described with particular attention to three types of impurities: calcium from "industrial grade" sodium, oil from the mechanical pumps and hydrogen from the steam generators.

56488 (CONF-760503—P1, pp 83-93) **Identification of impurities in sodium and its purification.** Subbotin, B.I.; Voltchkov, L.G.; Kozlov, F.A.; Zagorulko, Yu.I.; Kuznetsov, E.K. (Inst. of Physics and Power Engineering, Obninsk, USSR). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The paper presents some investigation results on sodium technology. In particular, a description is given of a calculation method for evaluation of sodium-cover gas-impurities equilibrium compositions as well as experimental results on development of methods for sodium sampling, equipment for non-metallic impurities (oxygen, hydrogen, carbon) constant control in sodium. The investigation results on sodium purification with cold traps are presented.

56489 (CONF-760503—P1, pp 94-104) **Sodium and cover gas chemistry in the high temperature sodium facility.** McCown, J.J.; Duncan, H.C. (Hanford Engineering Development Lab., Richland, WA). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The equipment and procedures used in following sodium and cover gas chemistry changes in the High Temperature Sodium Facility are presented. The methods of analysis and results obtained are given. Impurity trends which have been measured during the facility operations are discussed.

56490 (CONF-760503—P1, pp 105-111) **Sodium characterization during the starting period of a sodium loop.** Lievens, F.; Parmentier, C.; Soenen, M. (SCK/CEN, Mol, Belgium). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

A sodium loop for analytical chemistry studies has been built by S.C.K./C.E.N. at Mol Belgium. Its first working period was used to test analytical methods, to characterize the sodium and to define the operating parameters of the loop. This report covers the working parameters of the loop, the characterization of the filling sodium and its purity evolution during the first working period of the loop.

56491 (CONF-760503—P1, pp 116-121) **Operational techniques employed for the liquid sodium source term control loops.** Chulos, L.E. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Four Source Term Control Loops (STCLs) have been designed, constructed, and placed into operation at the Hanford Engineering Development Laboratory (HEDL) as part of the Radioactivity Control Technology program. The data obtained are used to determine the corrosion and deposition of LMFBR materials, including corrosion product radionuclides, in a non-isothermal flowing sodium system. The paper discusses operation of the STCL Facilities and, in particular, the methods used for controlling the oxygen content of the liquid sodium. These methods include cold trapping techniques, hot trapping, seeding the cold traps with sodium oxide, and precipitating the oxygen in the cold trap in a controlled manner. Operational problems encountered with the STCL Facilities and the techniques for correcting these problems are also discussed.

56492 (CONF-760503—P1, pp 122-130) **Development of low friction materials for LMFBR components.** Johnson, R.N. (Westinghouse-Hanford Co., Richland, WA); Aungst, R.C.; Hoffman, N.J.; Cowgill, M.G.; Whitlow, G.A.; Wilson, W.L. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The number of materials capable of providing low friction, low wear, and good corrosion resistance in low-oxygen (less than 1 ppM) sodium at temperatures up to 650°C are extremely limited. The paper describes the development, evaluation, and qualification of low-friction materials for this environment with emphasis on chromium carbide base coatings and nickel aluminide diffusion coatings. Design criteria and typical applications in liquid-metal-cooled reactors are described and recommendations offered for conditions under which these materials should and, perhaps more importantly, should not be used. Design parameters required to achieve optimum performance of these materials are discussed.

56493 (CONF-760503—P1, pp 131-137) **Friction and wear in liquid-metal systems: comparability problems of test results obtained from different test facilities.** Wild, E.; Mack, K.J. (Kernforschungszentrum, Karlsruhe, Ger.). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Operational induced relative movements take place between contacting components in the core region of sodium cooled reactors. To ensure reliable long term functioning of such friction loaded components, materials are needed with good sliding properties and high wear resistance. Therefore, tribological properties of material combinations in liquid metal have been investigated experimentally for many years at various research establishments. However, despite identical boundary conditions, the comparison of results published does not yield a satisfactory agreement. The cause must be seen in the individual design and concept of the test sections used. This discrepancy was investigated. The results show that the elasticity, mass movement, and relative motion characteristic to the system prove to be the most important criteria influencing the test results.

56494 (CONF-760503—P1, pp 138-144) **Corrosion and tribological investigations of chromium carbide coatings for sodium cooled reactor applications.** Whitlow, G.A. (Westinghouse Advanced Reactors Division, Madison, PA); Wilson, W.L.; Galioto, T.A.; Miller, R.L.; Schrock, S.L.; Hoffman, N.J.; Droher, J.J.; Johnson, R.N. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The dynamic and static friction behavior of chromium carbide coatings containing Nichrome, Inconel 718, or Tribaloy 700 as binder materials has been investigated in sodium environments at temperatures ranging from 232 to 627°C (450 to 1160°F). In general, dynamic friction coefficients of these materials at 232°C were found to be less than or equal to 0.4, but increased with temperature and cumulative rubbing, with values as high as 0.9 observed at 627°C following extensive rubbing. The detonation gun applied chromium carbide/Nichrome coated 316 stainless steel, exhibited a definite self-bonding tendency in high purity sodium, but little wear was observed. Static or breakaway friction coefficients were influenced by temperature, dwell time, contact pressure, and the presence of tangential forces at the contacting interfaces. Friction coefficients at 627°C were significantly lower for irradiated material than for similar unirradiated coatings.

56495 (CONF-760503—P1, pp 145-152) **Experimental investigations of the frictional and wear behavior of tungsten carbide cermet ball bearings under axial load in liquid sodium.** Kleefeldt, K.W. (Kernforschungszentrum, Karlsruhe, Germany). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The paper describes part of the R and D work performed on ball bearings operated in a liquid sodium environment and tested under conditions which are felt to be representative for high precision mechanisms in LMFBR's. After a short introduction, mainly dealing with the experimental results of other authors, a description will be given of the test facility, the test procedure, the ball bearings and the basis for the selection of the materials. The paper covers the experimental phase, which has been carried out in two steps. In the first phase material screening tests demonstrated the tungsten-carbide-cobalt cermet to be superior to the other materials tested with respect to friction and wear. This material, therefore, was selected for a more detailed parameter test programme during phase 2. Up to now a series of tests have been performed with bearing load and speed as parameters, indicating that fatigue is the life limiting factor. It shows that a life-load relationship, similar to that known for conventional ball bearing technology, also seems appropriate for the test conditions and environment investigated here.

56496 (CONF-760503—P1, pp 153-159) **Friction and wear behavior of Colmonoy and Stellite alloys in sodium environment.** Kanoh, S.; Mizobuchi, S.; Atsumo, H. (Power Reactor and Nuclear Fuel Development Corp., Oarai, Japan). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

A description is given of a series of experiments in sodium environment for the research and development of friction and wear resistant material used for the sliding components of sodium cooled fast breeder reactor. The study relates to the friction and wear characteristics of nickel-base alloy, Colmonoy, and cobalt-base alloy, Stellite, with respect to temperature, load, sliding velocity, sliding mode, and sodium flushing. The friction behavior of these alloys in sodium is compared with that in argon.

56497 (CONF-760503—P1, pp 160-166) **Wear of rolling element bearings in sodium.** Campbell, C.S. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Rolling element bearings and related mechanisms are attractive for service in liquid sodium but it is not clear what minimum wear rate can be anticipated. For axially loaded angular contact bearings rotation is incompatible with pure rolling on both races and wear arises from the resulting ball spin. The initial pressure distributions and sizes of the contact ellipses can be calculated but will change with bearing wear. However, the most effective distribution for producing wear would be for the full loads to be borne on the tips of the contact areas, whose maximum length is given by examination of the race wear tracks. A calculation on such a basis should set a lower limit for the wear coefficient. Both the torque and instantaneous wear rate of a bearing will be similar functions of the integral over the contact areas of the product of contact pressure and radius from the ball spin axis. A better estimate of wear coefficient should be obtained by relating the average torque, the average wear, the initial torque and the initial wear where the conditions are known. Analysis of tests in sodium at 400°C of high speed steel and Stellite bearings by these methods indicates specific wear rates of the order of 10^{-15} m^3/N-m, not unduly out of line with the range of values found in conventional sliding tests.

56498 (CONF-760503—P1, pp 167-176) **Evaluation of cobalt and nickel base materials for sliding and static contact applications in a liquid metal fast breeder reactor.** Hoffman, N.J. (Liquid Metal Engineering Center, Canoga Park, CA); Droher, J.J.; Chang, J.Y.; Galioto, T.A.; Miller, R.L.; Schrock, S.L.; Whitlow, G.A.; Wilson, W.L.; Johnson, R.N. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The paper covers pertinent metallurgical and tribological aspects of three alloys that are being considered for surfaces that must rub while immersed in liquid sodium coolant within a fast breeder reactor system. The alloys are cobalt-base hardfacing alloy type 6, Tribaloy 700, and Inconel 718. Topics discussed include chemistry and microstructure, hardness, and behavior in high-temperature sodium with respect to dynamic friction, diffusion bonding, and corrosion.

56499 (CONF-760503—P1, pp 177-186) **Investigations into the self-welding behavior of metallic materials exposed to sodium.** Huber, F.; Mattes, K. (Kernforschungszentrum, Karlsruhe, Germany). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

To determine the parameters responsible for selfwelding, experimental investigations were carried out at the Karlsruhe Nuclear Research Center. These activities are related to the SNR 300 prototype sodium-cooled fast breeder reactor. The experimental equipment, test materials and conditions as well as the results obtained are described and an attempt is made to present a general applicable explanation of the self-welding phenomena.

56500 (CONF-760503—P1, pp 187-188) **Development and testing of high-performance fuel pin simulators for boiling experiments in liquid metal flow.** Casal, V. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

There are unknown phenomena, about local and integral boiling events in the core of sodium cooled fast breeder reactors. Therefore at GfK depend out-of-pile boiling experiments have been performed using electrically heated dummies of fuel element bundles. The success of these tests and the amount of information derived from them depend exclusively on the successful simulation of the fuel pins by electrically heated rods as regards the essential physical properties. The report deals with the development and testing of heater rods for sodium boiling experiments in bundles including up to 91 heated pins.

56501 (CONF-760503—P1, pp 188-189) **Dynamic response of the EBR-II secondary sodium system to postulated leaks of steam and water into sodium.** Srinivas, S.; Chopra, P.S.; Stone, C.C. (Argonne National Lab., IL). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The paper presents evaluations of the dynamic response of a steam generator system to postulated leaks of steam and water into sodium. This work is part of a comprehensive fail-safe analysis of the EBR-II steam generator system.

56502 (CONF-760503—P1, pp 189-190) **Events following postulated failures in the EBR-II steam generator system.** Wolz, G.C.; Gukeisen, C.; Chopra, P.S. (Argonne National Lab., IL). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The progression of events following three postulated spontaneous failure initiating events in the steam generator system of the EBR-II are described with the help of fault trees and accident progression diagrams. The analyses are presented for reactor operating and standby conditions since the consequences differ in the two cases.

56503 (CONF-760503—P1, pp 193-201) **Materials engineering issues, LMFBR steam generators.** Spalaris, C.N.; Challenger, K.D.; Day, R.A.; Dutina, D.; Ring, P.J. (General Electric Co., San Jose, CA). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Selection of 2-1/4 Cr-1 Mo as the reference construction material for LMFBR steam generators assumed a balance between its known intrinsic properties and our ability to accommodate certain of its deficiencies through design allowance. A comprehensive development program was undertaken to define base data needed, confirm assumptions made relative to desired performance, minimize defects by optimization of melting, fabrication and heat treatment processes, and prepare specifications for purchasing reactor components.

56504 (CONF-760503—P1, pp 202-210) **Some problems of leaks in sodium-water steam generator.** Kozlov, F.A.; Sergeev, G.V.; Sednev, A.R.; Makarov, V.M. (Inst. of Physics and Power Engineering, Obninsk, USSR). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The paper contains data on wastage of steam generator structural materials and high-nickel alloys in the zone of water leakage into sodium as well as investigation results for self-enlargement of water leaks into sodium through defects in these materials. It is shown that the rate of material damage in the zone of sodium-water reaction and in the channel with water leaking-out decreases with increasing nickel content in steels and strongly depends on sodium temperature. The paper presents experimentally obtained dependences of leakage self-enlargement rates on sodium temperature and leakage size.

56505 (CONF-760503—P1, pp 211-217) **Qualification of Alloy 800 for sodium heated steam generators.** Duke, J.M.; Sessions, C.E.; Ray, W.E. (Westinghouse Electric Corp., Tampa, FL). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

A reference specification of Alloy 800 for use in LMFBR steam generators is defined considering waterside corrosion, weldability and mechanical properties. Additional mechanical test data are being generated to support ASME Code acceptance. Candidate weld filler metals were assessed for use in subsequent weld process development. Progress on resolving technical concerns related to the role of tertiary creep identified the impact of test conditions and gamma prime strengthening in determining the creep behavior of Alloy 800.

56506 (CONF-760503—P1, pp 218-225) **Calculation of wastage by small water leaks in sodium heated steam generators.** Tregonning, K. (Dounreay Experimental Reactor Establishment, Scotland). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

On the basis of mechanistic arguments it is suggested that the temperature of the wasting surface would provide a single physically meaningful parameter with which to correlate wastage data. A lumped parameter model is developed which predicts reaction temperature as a function of the major variables in the small water leak situation (Leak rate, tube spacing, sodium temperature). The calculated temperatures explain much of the observed behaviour of wastage rate with these variables and compare well with the limited temperature data available. Wastage rates are correlated with predicted temperature on a total activation energy basis. The results are encouraging and a first conservative method for the calculation of wastage by small water leaks in sodium-heated steam generators is produced.

56507 (CONF-760503—P1, pp 226-232) **Small leak shutdown, location, and behavior in LMFBR steam generators.** Sandusky, D.W. (General Electric Co., San Jose, CA). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The paper summarizes an experimental study of small leaks tested under LMFBR steam generator conditions. Defected tubes were exposed to flowing sodium and steam. The observed behavior of the defected tubes is reported along with test results of shutdown methods. Leak location methods were investigated. Methods were identified to open plugged defects for helium leak testing and detect plugged leaks by nondestructive testing.

56508 (CONF-760503—P1, pp 233-241) **Small leak damage and protection systems in steam generators.** Greene, D.A. (General Electric Co., Sunnyvale, CA). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

A small leak of water into sodium in a liquid metal heated steam generator can cause damage to adjacent tubes, a phenomenon termed wastage. Theories on this phenomenon range from corrosion from sodium water reaction products to erosion by supersonic particles. An alternative approach considers the water injection to form a simple combustion process. Using this approach many aspects of over 250 wastage experiments can be explained both analytically and physically. The U.S. has an extensive technology in the general area of acoustic surveillance. High temperature in-sodium microphones, in-vessel waveguides, and data analysis techniques have been successfully demonstrated in national development programs. This technology has been applied specifically to the development of an acoustic leak detection/location monitor for small leaks in an operating steam generator.

56509 (CONF-760503—P1, pp 242-247) **Large scale sodium-water reaction tests for Monju steam generators.** Sato, M.; Hiroi, H.; Hori, M. (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

To demonstrate the safe design of the steam generator system of the prototype fast reactor Monju against the postulated large leak sodium-water reaction, a large scale test facility SWAT-3 was constructed. SWAT-3 is a 1/2.5 scale model of the Monju secondary loop on the basis of the iso-velocity modeling. Two tests have been conducted in SWAT-3 since its construction. The test items using SWAT-3 are discussed, and the description of the facility and the test results are presented.

56510 (CONF-760503—P1, pp 256-262) **Sodium and steam leak simulation studies for fluidized bed steam generators.** Keeton, A.R.; Vaux, W.G.; Lee, P.K.; Witkowski, R.E. (Westinghouse Research Labs., Pittsburgh). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

An experimental program is described which was conducted to study the effects of sodium or steam leaking into an operating fluidized bed of metal or ceramic particles at 680 to 800°K. This effort was part of the early development studies for a fluidized-bed steam generator concept using helium as the fluidizing gas. Test results indicated that steam and small sodium leaks had no effect on the quality of fluidization, heat transfer coefficient, temperature distribution, or fluidizing gas pressure drop across the bed. Large sodium leaks, however, immediately upset the operation of the fluidized bed. Both steam and sodium leaks were detected positively and rapidly at an early stage of a leak by instruments specifically selected to accomplish this.

56511 (CONF-760503—P1, pp 263-270) **Radioactive corrosion product transport and control.** Brehm, W.F. (Hanford Engineering Development Lab., Richland, WA). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Buildup of radioactive species in primary system piping and components of LMFBR's will occur due to transport of radioactive materials from the reactor core to external piping and components. This buildup will give rise to gamma radiation fields strong enough to cause difficulty in maintenance and repair operations. The strength of the radiation fields will depend strongly on the reactor operating temperature and the effectiveness of control measures applied. Sodium-cooled reactors with core outlet temperatures of about 500 to 550°C have experienced significant amounts of radioactive corrosion product transport. It is predicted that reactor operations with core outlets near 600°C and with the long fuel cycles necessary for maximum breeding gain will produce radiation fields of over 1R/hr adjacent to some primary heat transport system equipment. Experience on existing reactors has shown that maintenance is cumbersome, expensive, and time consuming under such conditions.

56512 (CONF-760503—P1, pp 278-279) **On-line separation of radioiodine in highly radioactive EBR-II sodium.** Villarreal, R.; Miles, C.C. (Argonne National Lab., Idaho Falls, ID). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Radioiodine in molten sodium cooled to approximately 100 to 130°C (373-403°K) will quantitatively segregate to the walls of a stainless steel vessel and remain after the sodium is drained off. This segregation phenomenon is the basis for the rapid and quantitative separation of I-131 from highly radioactive sodium for subsequent determination by radiochemical techniques. The paper reports the results of experiments conducted to determine the segregation and redistribution of I-131, and certain other nuclides, in molten sodium in the temperature range of 100 to 370°C (373 to 643°K). The success of these experiments led to the system proposed for the on-line separation of radioiodine from highly radioactive EBR-II sodium. Radioiodines determined within 2 to 4 hours after sampling

will greatly aid in the characterization of fuel-cladding failures in LMFBRs.

56513 (CONF-760503—P1, pp 280-283) **Computational technique for estimating corrosion product release in an LMFBR.** Kuhn, W.L. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

A model is developed to predict the release of activated corrosion products in an LMFBR. Model parameters are obtained from literature correlations and from fitting the model to release rates observed in experimental sodium loops. The model is simplified to consider only two cases: release controlled by corrosion only or controlled by simultaneous corrosion and diffusion only. The release rates, radionuclide inventories, and resulting radiation fields near primary system components are predicted for the Fast Flux Test Facility as a function of operating temperature, oxygen concentration in the sodium, and time of operation. Saturation inventories are reported for ^{54}Mn, ^{60}Co, ^{58}Co, ^{51}Cr, and ^{59}Fe. The resulting radiation fields are due mainly to ^{54}Mn, and are found to reach the 5 R/hr range for operation at a core outlet temperature of 593°C.

56514 (CONF-760503—P1, pp 284-290) **Fission product measurements in the inpile fission product loop.** Mitsutsuka, N.; Gohshi, Y.; Shimojima, H.; Feuerstein, H. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe, Ger.). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The behavior of fission gases in a circulating sodium system was investigated. The release rates to the covergas were strongly influenced by the sodium temperature. For the system I-135 /Xe-135 m, Xe-135 the release behavior of the xenon isotopes followed exactly the adsorption of iodine within the loop. The behavior of nuclides formed during irradiation is more complex and could not be explained completely. Two kinds of half lives for the degassing process were found. Degassing half lives in the range of 17 to 32 minutes are explained by diffusion through the sodium-covergas interface. Another kind of degassing half life, ranging from 80 to over 200 minutes must be explained by some special features of the system.

56515 (CONF-760503—P1, pp 291-297) **Fission product deposition in a stainless steel sodium system.** Mitsutsuka, N. (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan); Gohshi, Y.; Shimojima, H.; Feuerstein, H. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Deposition of longer half lived fission products in a stainless steel inpile sodium loop was investigated. A strong down stream effect was found on inlet and outlet pipes to the uranium dioxide fuel. Deposition of iodine and tellurium was strongly affected by the loop temperature, showing higher deposition at lower loop temperature. Cold trapping of the fission product containing sodium was also investigated, using the attached cold trap loop. Iodine and cesium were found to deposit reversibly to the cold trap.

56516 (CONF-760503—P1, pp 304-312) **Radiochemical measurement of mass transport in sodium.** Cooper, M.H. (Westinghouse Electric Corp., Madison, PA); Chiang, S.H. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Mass transport processes in the sodium coolant of Liquid Metal Fast Breeder Reactors (LMFBRs) are significant in determining rates of corrosion and deposition of radioactive nuclides from the fuel cladding, deposition and cold trapping of fission products from defect or failed fuel, carbon and nitrogen redistribution in the containment materials, and removal of impurities by cold trapping or hot trapping. Mass transport between rotating, concentric cylinders in molten sodium has been investigated using a unique radiochemical method. Long-lived (33 year) cesium-137, dissolved in the sodium, decays radioactively emitting a beta to barium-137m, which decays with a short half-life (2.6 minutes) emitting a gamma. Cesium is weakly adsorbed and remains in solution, while the barium is strongly adsorbed on the stainless steel surfaces. Hence, by measuring the barium-137m activity on movable stainless steel surfaces, one can calculate the mass transport to that surface. Mass transfer coefficients in sodium measured by this method are in agreement with published heat transfer correlations when the effect of the volumetric mass source is taken into account. Hence, heat transfer correlations can be confidently utilized by analogy in estimating mass transfer in liquid-metal systems.

56517 (CONF-760503—P1, pp 313-323) **Material effects in LMFBR sodium systems.** Dietz, W.; Grosser, E.D.; Lorenz, H. (INTERATOM, Bensberg, Ger.). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The operating conditions of commercial LMFBR's can result in material performance problems. Corrosion, radiation damage, temperature requirements, plastic deformation, and the superposition of these effects have been defined as important limiting factors for the design of components. A detailed knowledge of the various parameters which can influence the behavior of materials under LMFBR conditions is therefore necessary. The objective of the paper is to identify the influence of the sodium environment on the most important properties of materials which are used for the construction of heat transfer components. The paper considers the fuel cladding, the IHX, and the steam generator to be the major heat exchange units to be evaluated.

56518 (CONF-760503—P1, pp 324-330) **Effect of liquid sodium thermochemical reactions with stainless steels on mechanical response.** Subbaraman, G.; Reifsnider, K.L. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

An analytical approach is presented to study the elastic response of an LMFBR fuel clad subject to strong property degradation in liquid sodium environment and internal poison pressure, at the gas plenum section of the fuel pin. The nature and analysis of the thermochemical reactions and the available experimental data are briefly reviewed. Property variations in the radial direction due to these inservice reactions are represented by a generalized, continuous function, f(r), which is introduced into the constitutive equations of stress equilibrium. By introducing an adjustable constant A into a specific form of f(r), various severities in the variation of the elastic parameters through the thickness of the clad are accommodated and particular analytical solutions are obtained for the displacement. Closed form solutions, which are available for particular values of A, are used as validity checks in computing the more general solutions. The stress-strain responses including the deviatoric stresses used in creep analyses are presented for several cases. The merits of the analytical formulation of the problem and the need to include similar approaches in fuel performance calculations are stated.

56519 (CONF-760503—P1, pp 331-337) **Influence of sodium on the mechanical properties of fuel element cladding.** Borgstedt, H.U.; Frees, G. (Kernforschungszentrum, Karlsruhe, Ger.). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The creep and corrosion behaviour of cladding tubes of austenitic stainless steels has been tested in a test series up to 10,000 hours. The test temperature has been 873 resp. 973°K, the flow velocity 5 m/s. The purity of the sodium has been varied within the range 3.5 to 9 w-ppM oxygen. The weight losses depend linearly on the oxygen content of the sodium, and the temperature dependence follows an ARRHENIUS law. Metallurgical and analytical examinations show that more than a third of the wall thickness suffers changes of composition and microstructure at 973°K. The observed phenomena are ferritic surface layers, grain boundary ferritization, carburization, increases of hardness, and finally weak carburization. In spite of the changes due to the sodium corrosion the largest part of the specimens does not show losses of creep strength. However, cold worked specimens of 1616CrNiMoNb creep with accelerated rates. The examinations lead to the conclusions that changes in microstructure may have caused the loss of creep strength of this material.

56520 (CONF-760503—P1, pp 346-352) **Influence of dynamic sodium on the creep properties of stabilized austenitic steels.** Tas, H. (SCK/CEN, Mol, Belgium); Casteels, F.; Schirra, M. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Uniaxial creep tests on X8CrNiMo V Nb 1613 (DIN 1.4988) and X10NiCrMoTiB 1515 (DIN 1.4970) tubes have been carried out at 700°C both in dynamic sodium and in vacuum at different stress levels in order to establish the influence of a well-defined sodium quality on the secondary creep rate, the onset of tertiary creep, the time-to-rupture, and the fracture mechanism for these stabilized austenitic steels. Mechanisms which can be responsible for changes of creep properties are diffusion-controlled processes such as preferential leaching of substitutional elements and loss or pick-up of interstitial elements; furthermore, physico-chemical processes such as general corrosion, grain boundary grooving, surface pitting and crack promoting processes. The observed structural and chemical changes have been evaluated and cannot be responsible for variations of the creep parameters. The dynamic sodium environment promotes intergranular cracking in the DIN 1.4988 steel, whereas in the DIN 1.4970 steel rapid local corrosion in deformation bands causes the growth of an irregular branched fracture path from the sodium exposed surface. However, the main creep parameters of both steels are not significantly influenced by the presence of flowing sodium.

56521 (CONF-760503—P1, pp 353-358) **Low cycle fatigue testing in flowing sodium at elevated temperatures.** Flagella, P.N.; Kahrs, J.R. (Westinghouse Electric Corp., Madison, PA). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The paper describes equipment developed to obtain low cycle strain-controlled fatigue data in flowing sodium at elevated temperatures. Operation and interaction of the major components of the system are discussed, including the calibration technique using remote strain measurement and control. Confirmation of in-air results using the special technique is demonstrated, with data presented for Type 316 stainless steel tested in high purity flowing sodium at 593°C. The fatigue life of the material in sodium is essentially the same as that obtained in air for delta epsilon/sub t/= 1 percent. On the other hand, sodium pre-exposure at 650°C for 5000 hours increased the fatigue life in-sodium by a factor of two, and sodium pre-exposure at 718°C for 5000 hours increased the fatigue life in-sodium by a factor of three.

56522 (CONF-760503—P1, pp 368-377) **Corrosion, transport, and deposition of stainless steel in liquid sodium.** Kolster, B.H.; Bos, L. (Metaalinstituut TNO, Apeldoorn, Netherlands). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

With a nonisothermal multi-purpose sodium loop system experiments have been carried out to reveal the influence of oxygen level, flow velocity, temperature, and downstream position on corrosion of and deposition of stainless steel AISI 316 specimens. The exposed specimens have been characterised by means of weight change and metallographic appearance. A different mechanism of Cr-transport can be distinguished at low and high oxygen concentration. The activation energy for the steady state corrosion at low oxygen level is 40 kcal/mol. With Reynolds no. in excess of 50,000 no influence of flow velocity on corrosion has been observed. The same holds for deposition in a nonisothermal circuit, but not under isothermal conditions, for which an explanation is given. Magnetic measurements revealed that downstream effects are mainly caused by ferritisation.

56523 (CONF-760503—P1, pp 378-385) **In-reactor corrosion behavior of stainless steel in high temperature sodium.** Weber, J.W. (Westinghouse-Hanford Co., Richland, WA). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Sodium-cladding chemical interaction has been studied on fuel pins clad with 20 percent cold worked type 316 stainless steel and irradiated in the EBR-II at temperatures up to 705°C and for exposures to 5300 hours. The measured corrosion rate of the cladding surface immediately above the top of the fuel column was 12.5 μm per year at 690°C. The loss of Ni at 700°C resulted in the formation of a ferrite layer approximately 5 μm thick. A zone depleted in Ni and Cr extends into the austenite from the ferrite-austenite interface an additional distance of approximately 15 μm. No large changes in volumetric average carbon or nitrogen were observed. The results suggest a slight increase in carbon during the first 2300 hours followed by a slow decrease for longer exposure times. A 25 to 30 percent decrease in bulk nitrogen was observed in cladding with an initial nitrogen content of 225 ppM. Cladding with a lower initial nitrogen content of 63 ppM showed essentially no change. Fuel pin cladding corrosion behavior agrees well with that predicted using out-of-reactor Na loop data, thus providing confidence that out-of-reactor corrosion data can be reliably used in predicting in-reactor fuel cladding performance.

56524 (CONF-760503—P1, pp 386-392) **Influence of LMFBR fuel pin temperature profiles on corrosion rate.** Shiels, S.A.; Bagnall, C.; Schrock, S.L.; Orbon, S.J. (Westinghouse Electric Corp., Madison, PA). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The paper describes the sodium corrosion behavior of 20 percent cold worked Type 316 stainless steel fuel pin cladding under a simulated reactor thermal environment. A temperature gradient, typical of a fuel pin, was generated in a 0.9 m long heater section by direct resistance heating. Specimens were located in an isothermal test section immediately downstream of the heater. A comparison of the measured corrosion rates with available data showed an enhancement factor of between 1.5 and 2 which was attributed to the severe axial temperature gradient through the heater. Differences in structure and surface chemistry were also noted.

56525 (CONF-760503—P1, pp 393-399) **Corrosion of steels in liquid sodium.** Clement, C.F.; Hawtin, P. (Atomic Energy Research Establishment, Harwell, Eng.). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Proposed expressions for the corrosion and deposition rates and other relevant data are examined theoretically using models which treat both particle and molecular transport and the coupling between particle and molecular concentrations. It is difficult to reconcile some properties of the observed rates, including sodium velocity dependence, with currently accepted best values for the equilibrium iron concentration in sodium. To overcome this difficulty a new model is proposed which contains two iron solubilities, one with and one without association with oxygen, which can also explain some existing anomalies in solubility measurements. The models also give a qualitative understanding of some properties of particles in circuits including the observed size distribution.

56526 (CONF-760503—P1, pp 400-406) **Thermodynamic and diffusion studies on corrosion of austenitic stainless steel in liquid sodium.** Konvicka, H.R. (Univ., Vienna); Komarek, K.L.; Schreinlechner, I.E. Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Critical oxygen concentrations for formation of double oxides of sodium and steel constituents at the sodium-steel interface are derived. Under loop conditions only chromite can be formed. Stainless steel samples were investigated after 2600 hours exposure time to sodium at 730°C by means of a scanning electron microscope with an energy dispersive X-Ray analyzer (EDAX), X-Ray-diffraction and metallography. Results are used to propose a diffusion model of steel corrosion. The downstream effect and velocity dependence of corrosion are explained as functions of grain boundary diffusion and iron corrosion.

56527 (CONF-760503—P1, pp 407-417) **Solubility of oxygen in liquid sodium: effect on interpretation of corrosion data.** Claxton, K.T. (Atomic Energy Research Establishment, Harwell, Eng.). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

No solubility correlation relating the equilibrium oxygen concentration with the sodium saturation temperature has yet been derived which has gained general acceptance. A statistical analysis of all the available data which directly or indirectly may be taken as representing a measurement of solubility has been made. The results indicate that a real and seemingly permanent difference is apparent between the assumed equilibrium levels of oxygen measured at different saturation temperatures as reported by UK and US workers. Data analysis procedures producing sub-sets of culled data which are then used to derive a compromise solubility function are considered less than adequate. It is considered preferable and more realistic to distinguish data sub-sets by the analytical technique employed. The established vacuum distillation method is shown to yield results differing among themselves by up to a factor of four at cold trap temperatures of relevance to fast reactor operation. The

vanadium wire and electrochemical cell techniques are shown to give the lowest solubility values. Appropriate factors relating UK oxygen levels to values derived from alternative methods are presented. The divergent positions prevailing for oxygen-in-sodium analysis can lead to apparent anomalies when comparisons of corrosion rates from different sources have to be made. It is shown that this situation is, in part, apparently resolved by effecting comparisons at the equivalent cold trap temperature instead of the equivalent oxygen level. It is recognised that the approach presumes equilibrium of the oxygen in the sodium with the cold trap and reference is made to alternative "sinks" for oxygen. It is demonstrated, by comparison of a number of recommended and observed corrosion rates from US and European sources, that, in spite of the above and other qualifications, the approach is reasonable.

56528 (CONF-760503—P1, pp 418-426) **Compatibility of structural materials with boiling potassium.** DeVan, J.H. (Oak Ridge National Lab., TN). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The suitability of iron-, nickel-, and cobalt-base alloys for use as structural materials in boiling-potassium systems is examined with particular attention to corrosion and mass transfer. Corrosion results for high-temperature sodium and potassium loops are summarized and related to the corrosion requirements of a boiling-potassium Rankine-cycle system. This analysis indicates that, in a recirculating boiler with an efficient vapor separator, mass transfer effects will be counter to those in an all-liquid system. Solution will be restricted to the cooler zones and deposition to the hottest zone (i.e., the boiler) as potassium is distilled off and dissolved material is left behind. This hypothesis is evaluated against the data available for boiling-potassium systems, and the results observed are consistent with the hypothesis. Mass transfer rates are notably lower than in all-liquid systems, and in the absence of contamination effects recirculating boilers have shown negligible corrosion.

56529 (CONF-760503—P2) **Proceedings of the international conference on liquid metal technology in energy production.** Cooper, M.H. (ed.). (American Nuclear Society, Hinsdale, Ill.; American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc., New York; Energy Research and Development Administration, Washington, D.C. (USA); American Nuclear Society, Pittsburgh, Pa. Pittsburgh Section). Nov 1976. 460p. Dep. NTIS, PC A20/MF A01.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

Each paper in the volume has been separately abstracted and indexed. (DG)

56530 (CONF-770611—6) **Optimized method for orificing LMFBR cores.** Carelli, M.D.; Friedland, A.J.; Bach, C.W.; Markley, R.A. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). 1977. Contract EY-76-C-15-2395. 6p. Dep. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; New York, New York, United States of America (USA) (12 Jun 1977).

A novel approach to orificing Liquid Metal Fast Breeder Reactor (LMFBR) cores was developed as part of the thermofluids design of the heterogeneous core concept applicable to commercial as well as demonstration size LMFBR plants. The new concept presented here takes into account all constraints to be considered, i.e.: (1) assemblies lifetime; (2) transient limitations; (3) impact on Upper Internals Structure (UIS); (4) assembly power-to-flow considerations; and (5) cooling requirements of other components than core assemblies. A flow orificing allocation simultaneously satisfying the above constraints is thus developed.

56531 (COO—2245-38) **Coolant mixing in LMFBR rod bundles and outlet plenum mixing transients. Progress report, December 1, 1976—February 28, 1977.** Todreas, N.E.; Golay, M.W.; Wolf, L. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). 1977. Contract EY-76-S-02-2245. 66p. Dep. NTIS, PC A04/MF A01.

Information is presented concerning bundle geometry with wrapped and bare rods, subchannel geometry with bare rods, LMFBR outlet plenum flow mixing, and theoretical determination of local temperature fields in LMFBR fuel rod bundles.

56532 (COO—2512-10) **Mechanisms of vapor explosions. Technical progress report, October 1976—March 1977.** Bankoff, S.G.; Sharon, A.; Maeshima, M.; Inoue, A. (Northwestern Univ., Evanston, Ill. (USA). Dept. of Chemical Engineering). 1977. Contract EY-76-S-02-2512. 16p. Dep. NTIS, PC A02/MF A01.

Several studies are being performed related to destabilization of film boiling in liquid-liquid and liquid-solid systems due to local pressurization, in view of the key role of this step in initiating and propagating vapor explosions. A study of the destabilization of Leidenfrost boiling of single pentane drops on a hot silicone oil surface shows that pressure increases of less than one atm. are effective in producing vapor collapse with slow pressurization (rise time $\sim$ 0.5 sec.). For a given drop size the stability boundary in the ΔP vs. T/sub h/ plane shows two branches: a low-temperature branch which is independent of T/sub h/, and a higher-temperature branch showing a nearly llinear dependence of ΔP vs. T/sub h/. The corresponding critical Weber numbers for droplet coalescence are $\sim 10^3$, compared to $\sim 10^2$ for free-falling drops and $\sim$ 10 for droplet breakup due to inertial effects. Another study of film boiling destabilization with a rise time of $\sim 10^{-2}$ sec. shows that collapse occurs after only $\sim$ 1 to 2 atm. pressure rise, and that contact is made even when the heating surface is well above the critical temperature. Finally, in contradiction to a recently published study, boundary layer stripping in a UO_2-Na mixture is found to produce negligible breakup, and hence cannot escalate into a shock wave.

56533 (CRBRP-ARD—0166) **Clinch River Breeder Reactor Plant. Flow induced vibration of fuel rods in CRBRP.** Garkisch, H.D. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Jun 1977. Contract EY-76-C-15-0003;EY-76-C-15-2395. 67p. .

This report provides an overview of the existing knowledge on flow induced vibrations of fuel rods in LMFBR's, vibration related uncertainties, and planned testing to determine vibration amplitudes of fuel rods in CRBR. The experimental evidence from a large number of flow vibration tests of LWR type fuel assemblies, some LMFBR type fuel assemblies, and existing correlations, indicate that flow induced vibration in CRBRP fuel assemblies will be insignificant. However, LWR fuel rods are generally spaced by grids, whereas CRBR fuel rods are spaced by wire wrap. Due to these design differences existing design correlations to predict vibrations may not be applicable. It is not planned to derive design correlations because flow vibration tests of near prototypical rod bundles yield insignificant vibration amplitudes. Fuel rod vibration in a few nonprototypic EBR-II test assemblies caused significant vibratory cladding wear of approximately 0.005 inch. The cause for this wear was a large clearance between rod bundle and duct. A reduction of this clearance in subsequent tests eliminated the cladding wear damage since interim examinations of the test rod bundles show no evidence of significant cladding wear. The clearance between the rod bundle and the duct in CRBR will be minimized to reduce the wear potential. Although the flow induced vibrations of CRBR fuel rods measured in tests are expected to be insignificant, an additional flow induced vibration test is planned to verify this assumption. Such tests do not eliminate completely the potential for other vibration and wear phenomena to occur in the CRBRP environment. However, operation of fuel assemblies in FFTF will provide sufficient evidence that such vibrations do not occur in the CRBRP.

56534 (CRBRP-PMC—77-03) **Clinch River Breeder Reactor Plant technical review.** (Clinch River Breeder Reactor Plant Project Office, Oak Ridge, Tenn. (USA)). Sum 1977. Contract EY-76-C-15-1200. vp. .

A feature article on breeder economics discusses the key factors of electrical load growth, rate of addition of nuclear capacity, extent of high-grade U_3O_8 resources, and coal availability. Other articles cover shield design, irradiation effects on reactor structures, and detection of sodium leaks.

56535 (DLCS—5000177) **[Shippingport Atomic Power Station]. Quarterly operating report, first quarter 1977.** (Duquesne Light Co., Shippingport, Pa. (USA)). 1977. Contract EY-76-C-01-0292. 14p. Dep. NTIS, PC A02/MF A01.

A summary of reactor operations during the period is presented. Included are details on coolant chemistry and reactor maintenance.

56536 (ECN—9) **BOBL code. Experimental verification of the hydraulic model, including effects of pin bowing and grids.** Bloemen, H.A.; van den Bogaard, J.P.A.; Heil, J.A.; Hoornstra, J.; van der Putten, A.P.W.M. (Stichting Energieonderzoek Centrum Nederland, Petten). Dec 1976. 35p. Dep. NTIS (US Sales Only), PC A03/MF A01.

14 figs., 6 refs., 1 table.

The theoretical model of the subchannel code BOBL (i.e. BOwing and BLockages) treats the closely coupled flow, temperature, and pinbowing field in a fuel subassembly. The code also includes models for grids and blockages of various geometries. To investigate the hydraulic subprogram of the BOBL code separately, out-of-pile water experiments have been performed in an unheated bundle with straight and with prebowed rods. The bundle has been equipped with a number of grids. An evaluation of the experimental results is described.

56537 (EURFNR—1437) **THECA: a code system for 3-D thermohydraulic layout of fast reactors.** Doetschmann, K.; Amendola, A.

(Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). Mar 1977. 203p. (In German). (KFK—2372; EUR—5507d). Dep. NTIS (US Sales Only), PC A10/MF A01.

Work performed under Euratom Fast Reactor Exchange Program.

The THECA program system allows the designer to perform the complete 3-D thermal design of a fast reactor core. This means that the whole reactor core is taken into account. THECA consists of 3 principal modules: THELVU for the evaluation of the nominal 3-D power distribution in the reactor core; THESYS for the evaluation of the nominal temperature distribution in the reactor core; and THEDRA for the statistical hot spot analysis and design optimization. In this case optimum design means the achievement of maximum power density and coolant temperature rise across the core at given core geometry, neutron flux distribution and hot spot probability.

56538 (IWGFR—12) **International Working Group on Fast Reactors ninth annual meeting, Vienna, Austria, 30 March—2 April 1976. Summary report: Part II and Part III.** (International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors). 1976. 107p. (CONF-760396—(Summ.)). Dep. NTIS (US Sales Only), PC A06/MF A01.

From 9. meeting of the international working group on fast reactors; Vienna, Austria (30 Mar 1976).

The report contains seven papers presented by IAEA member nations which review the national programs in LMFBR development and operation. (DG)

56539 (LA—6808-PR) **Examination of fast reactor fuels, FBR analytical quality assurance standards and methods, and analytical methods development: irradiation tests. Progress report, January 1—March 31, 1977.** Baker, R.D. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). May 1977. Contract W-7405-ENG-36. 13p. Dep. NTIS, PC A02/MF A01.

This project is directed toward the examination and comparison of the effects of neutron irradiation on LMFBR Program fuel materials. Characterization of unirradiated and irradiated fuels by analytical chemistry methods will continue, and additional methods will be modified and mechanized for hot cell application. Macro- and microexaminations will be made on fuel and cladding, using the shielded electron microprobe, emission spectrograph, radiochemistry, gamma scanner, mass spectrometers, and other analytical facilities. New capabilities will be developed in gamma scanning, analyses to assess spatial distributions of fuel and fission products, mass spectrometric measurements of burnup and fission gas constituents and other chemical analyses. Microstructural analyses of unirradiated and irradiated materials will continue, using optical and electron microscopy and autoradiographic and x-ray techniques. Special emphasis will be placed on numerical representation of microstructures and its relationship to fabrication and irradiation parameters. New etching and mounting techniques will be developed for high burnup materials.

56540 (PNC-J—225-76-02) **Sodium environment effects to structural materials for fast reactors.** Hasegawa, M.; Fujimura, T.; Kondo, T.; Okabayashi, K.; Matsumoto, K. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Mar 1976. 201p. (In Japanese). Dep. NTIS (US Sales Only), PC A10/MF A01.

The material technology for liquid metal-cooling fast breeder reactors, the characteristic points are high temperature, liquid sodium as a heat medium, and high energy-high density neutron energy spectra, accordingly the secular change of materials due to these factors must be taken into the design. The project of material tests in sodium was started from the metallographical studies on corrosion and mass transfer phenomena in sodium environment, and was evolved to the tests and studies on short time strength, creep strength, fatigue strength, and embrittlement in sodium environment. Concerning the corrosion and mass transfer tests, low purity and medium purity material testing loops were employed, and the test of immersion in sodium was carried out. Domestically produced austenitic stainless steel and Cr-Mo steel were tested, and the measurement of weight change, surface inspection, and the observation of cross sectional structure were carried out before and after the immersion. The decrease of thickness due to the leaching of surface metal and the lowering of strength due to the change of composition or structure come into question only in case of very thin walled stainless tubes, and the lowering of heat transfer is negligible. Cr-Mo steel also showed good corrosion resistance in sodium, but the effect of decarbonization on the strength needs some investigation in the production specifications.

56541 (TRG-Report—2819(D)) **Operation of PFR and influence upon the design of CFR I.** Evans, A.D.; Macrae, W. (UKAEA Reactor Group, Dounreay. Dounreay Experimental Reactor Establishment; Nuclear Power Co. (Risley) Ltd. (UK)). Jun 1976. 19p. (CONF-751030—12). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International nuclear industries fair; Basel, Switzerland (7 Oct 1975).

The development of the LMFBR in the UK has proceeded in a series of steps by building reactors of increasing size, which it is intended should lead ultimately to large commercial fast reactor stations of standard design. The first stage in this progression was the construction in the 1950's of the experimental 14 MW(e) Dounreay Fast Reactor. The Dounreay Fast Reactor was followed by the 250 MW(e) Prototype Fast Reactor, PFR, which was built to prove the necessary features of a commercial reactor. The design of PFR was based on a prior design study of a 1000 MW(e) fast reactor station, and the choice of core design was largely dictated by the need for PFR to test designs of fuel suitable for a full size station. Among its objectives, PFR aimed to demonstrate reliable power plant operation and to test the reliability and performance of the type of components which would be necessary in a commercial reactor. The Prototype Fast Reactor will be succeeded by a lead station (CFR I) of full commercial size, i.e., of about 1300 MW(e) output, intended as the forerunner of an expanding installation programme of commercial stations; thus the experience and confidence gained from PFR forms the basis of progress to CFR I. The design of CFR I is now well advanced. It is being carried out by NPC Ltd under sponsorship from the UKAEA. Detailed design and development requirements are being formulated by NPC and the UKAEA with due regard to the needs of electrical utilities through close working association with the CEGB. This paper gives an outline of the current state of CFR I design and its relationship to experience derived from PFR.

56542 **Corrosion and creep of pressurized stainless-steel tubes in liquid sodium at 873 and 973°K.** Borgstedt, H.U.; Frees, G.; Schneider, H. (Kernforschungszentrum, Karlsruhe, Ger.). *Nucl. Technol.;* **34**: No. 2, 290-298(Jul 1977).

Corrosion and creep behavior of tubes fabricated of three German stainless steels have been studied in a 10,000-h test in a sodium loop at 873 and 973 K. The measured weight losses depend on the temperature and the oxygen content of the sodium. The results of metallographic examinations with respect to the formation of ferritic surface layers are in agreement with element concentration profiles obtained by analytical techniques. The stabilized stainless steels pick up carbon from the sodium even at 973 K although the carbon content of the liquid metal is in the range of 0.1 to 0.2 ppM. The measured carburization corresponds to the thermochemical data of both the steels and the liquid alkali metal. The creep rates of two of the steels are not influenced by the sodium, and the third material in the cold-worked condition shows an acceleration of the creep by a factor of 5. The different behavior cannot be explained by structural or chemical changes in the materials due to the action of sodium. Future examinations will clarify the different effects of sodium on the behavior of the slightly different materials.

56543 **Improved method for operating sodium system cold traps.** Chulos, L.E. (Hanford Engineering Development Lab., Richland, WA). *Nucl. Technol.;* **34**: No. 2, 306-307(Jul 1977).

More accurate control of cold-trap temperatures has been achieved by adding a resistance heater for fine temperature control, retaining a blower for rough control. This improved method of operating a cold trap provides a longer trap life.

56544 **Fuels characterization in LMFBR.** Sheely, W.F.; Alkire, G.J. (Westinghouse Hanford Co., Richland, WA). *Trans. Am. Nucl. Soc.;* **26**: 144-145(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56545 **Design and fabrication considerations for CRBRP ex-vessel storage tank (EVST).** Der Manuel, G. (Atomics International, Canoga Park, CA). *Trans. Am. Nucl. Soc.;* **26**: 260(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56546 **Relationships between nuclear growth rates and breeder doubling times.** Chang, Y.I.; Till, C.E. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 283-284(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56547 **Evaluation of LMFBR performance characteristics in the U.S. nuclear energy system.** Haffner, D.R.; Hardie, R.W.; Omberg, R.P. (Westinghouse Hanford Co., Richland, WA). *Trans. Am. Nucl. Soc.;* **26**: 284-285(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56548 Feasibility of denatured LMFBRs. Burns, T.J.; Bartine, D.E. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 285-286(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56549 Breeding performance optimization of helium-bonded carbide fuel in 1500-MW(e) LMFBRs. Kulwich, M.R.; Caspersson, S.A.; di Lauro, G.F.; Trumpler, D.A. (Combustion Engineering, Inc., Windsor, CT). *Trans. Am. Nucl. Soc.;* **26**: 286-287(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56550 Feasibility of plutonium separation-free nuclear power economy with LWHRs. Greenspan, E.; Schneider, A.; Misolovin, A. (Nuclear Research Center, Beersheva, Israel). *Trans. Am. Nucl. Soc.;* **26**: 305-306(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56551 Gas-cooled breeder reactor making progress in Europe. Chermanne, J. (Eur Assoc for the Gas-Cooled Breeder React, Brussels, Belgium). *Power Eng.;* **81**: No. 4, 74-77(Apr 1977).

Some $65 million have been put into development of the gas-cooled fast breeder reactor over the past decade in Europe and the United States. The European interests propose as their next step a program to construct a 600-MWe helium-cooled prototype fast breeder, leading to construction of a 1200-MWe commercial plant. Design of the three-loop 600-MWe unit will incorporate components such as boilers and circulators intended for the six-loop commercial plant, called BGR-4, so their performance and reliability can be tested ahead of commercial plant commitment. Other principal objectives of this plant are to test the performance and reliability of the reactor concept, serviceability of the fuel, and to provide an environment for proving high-performance fuel for advanced reactors operating at higher temperatures.

56552 Britain's prototype fast reactor: key to the commercial FBR systems. Olds, F.C. *Power Eng.;* **81**: No. 3, 36-43(Mar 1977).

Britain's Prototype Fast Reactor (PFR) is a 250-MWe sodium-cooled fast breeder reactor of the pool design. It is the third prototype fast reactor now in service in the world. The British developed PFR as a self-sustaining fast breeder system. It has a complete fuel cycle from fabrication to reprocessing and waste management. Support facilities, RandD, public health, safety, safeguards and fuel transport are included. PFR's nuclear side has been running with an availability of over 90%, but conventional side problems have been a steady aggravation. Troubles and all, however, knowledge from PFR is underpinning the concepts and designs for the oncoming commercial FBR systems.

56553 To breed or not to breed. Stauffer, T.R.; Wyckoff, H.L.; Palmer, R.S. (Harvard Univ, Cambridge, Mass). *Mech. Eng.;* **99**: No. 2, 32-41(Feb 1977).

Three results emerge with reasonable clarity from this analysis. The intrinsic uncertainty in the ultimate extent of the domestic low-cost uranium reserves is the most important single unresolved question which affects the economic benefits of breeder reactors. The nation's reserves of high-grade uranium must be many times presently projected resources to significantly reduce the need for the breeder. The breeder could cost significantly more than a light water reactor without impairing its overall advantage. Its own lower fuel cycle costs, plus its contribution to lower costs for companion converter reactors, could offset a several-fold greater capital cost. Successful introduction of advanced converter reactors--reoptimized versions of the HTGR's or the CANDU reactors--has no appreciable effect on the potential economic benefits from the breeder. The development cost of the breeder, therefore, may appropriately be regarded as an insurance premium paid to cover the nation against the possibility--or probability--that domestic low-cost uranium deposits cannot be significantly extended. It is concluded that a two-pronged mini-max strategy provides the least-cost program for guaranteeing secure sources of electric power: Sustain the RandD effort to develop the commercial breeder. Accelerate the program to delineate domestic uranium resources. 4 refs.

56554 Inelastic behavior of finite circular cylindrical shells. Chern, J.M.; Pai, D.H. (Foster Wheeler Energy Corp, Livingston, NJ). *J. Pressure Vessel Technol.;* **99**: No. 1, 31-38(Feb 1977).

Paper No. 76-PVP-42.

56555 Modelling and analysis of the PFR superheater toroidal header. Hay, E. (Canadian Met-Chem Consultants, Ltd., Montreal); Hellen, T.K. pp 45-53 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

A finite element analysis is presented for the assessment of stresses in a nozzle to toroidal header intersection in a PFR superheater. The BERSAFE stress analysis system, used for the computer analysis, is described. Because of the complex nature of the model, automatic data generation techniques are utilized and results produced by computer plotters are illustrated. The maximum stress concentration factors produced during the pressure case, attaining a value of 2.9, are shown to be adequate when assessed by ASME requirements.

56556 Thermal distortion of mock-up reactor vessel of fast breeder reactor. Matsumura, M. (Tokyo Shibaura Electric Co., Ltd.); Itoh, T.; Sakai, T.; Yokozawa, A.; Ohkawa, Y. pp 105-111 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

A test was made to obtain information on distortion of reactor vessels caused by thermal cycles. The vessel used in this test was constructed for testing a full scale mock-up of a fuel handling machine in high temperature sodium for the prototype FBR MONJU. The distortion of the test vessel was mainly caused by a thermal transient condition such as heating up or cooling down. Radial displacements at the top levels of dummy fuel assemblies did not exceed 4 mm.

56557 Design considerations of the Clinch River Breeder Reactor Plant intermediate heat exchanger. Pai, D.H. (Foster Wheeler Energy Corp., Livingston, NJ). pp 311-321 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

The paper discusses some of the design considerations of the Clinch River Breeder Reactor Intermediate Heat Exchanger (IHX). Particular emphasis is given to those areas which relate to the ASME Boiler and Pressure Vessel Code Section III and Code Case 1592. Several critical areas of the IHX are singled out for discussion to illustrate methods of approach used to satisfy the elevated temperature design criteria. These include (1) a nozzle and a tubesheet complex in which creep damage was found to be the controlling limit; (2) design considerations of a straight tube, particularly with respect to buckling under creep conditions; and (3) analytical and experimental qualification of a bellows designed to Section III Class 1 rules.

56558 Creep-fatigue test of an elbow subjected to cyclic in-plane moment loading. Nakamura, K. (Power Reactor and Nuclear Fuel Development Corp., Ibaraki, Japan); Nagata, T.; Imazu, A.; Miura, R.; Okabayashi, K. pp 787-794 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

The paper describes the results of a creep-fatigue test of an elbow-pipe assembly subjected to cyclic in-plane moment loading at 600 C. Controlled displacement was applied at one end of an elbow specimen of 12B Sch. 20S type 304 stainless steel. Behaviors under various loading wave forms were investigated at first, then one pattern with hold time at one extreme of the displacement wave was continued until a crack penetrated through the wall. Inelastic analysis was performed for a simplified loading pattern by a finite element program. Creep-fatigue evaluations were made on both the test data and the inelastic analysis results according to the Code Case 1592 and the strain-range partitioning method.

56559 Experiences on welding and testing during the construction of the austenitic reactor vessel for SNR 300. Herberg, G. (Interatom, Bensberg, Ger.); Sarnoch, H.; Wallner, F.; Kaser, A.; Mayrhofer, M. pp 893-906 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

For the construction of the SNR-1 reactor, a vessel was manufactured of fully austenitic material similar to Type AISI 304 SS. It was constructed from rolled plates (40 and 60 mm) and forged rings by using manual and submerged-arc welding. This was the first time that an unstabilized fully austenitic steel was successfully welded by submerged arc techniques. Some examples are given of the development of satisfactory welding procedures and of manufacturing operations. Special measures were taken for quality assurance, i.e. ultrasonic testing of the austenitic welds. The procedure used was based on transmitter-receiver techniques using longitudinal waves.

56560 Simplified method of computing clad and fuel strain and stress during irradiation. Sun, Y.H. Los Angeles; Univ. of California (1977). 301p. Microfilms Order No. 77-12,945.

Thesis (Ph. D.).

This dissertation develops a simplified, fast-running axisymmetric computer code, named KRASS (Kwik Running Analysis for Stress and Strain), intended for the prediction of fuel element conditions after long-term steady-state operation in a LMFBR. KRASS assumes that fuel restructuring has already occurred, and divides the fuel pellets into two zones, an inner, highly plastic hot region, and an outer, cooler region which together with the cladding can undergo creep. This code allows for fission gas pressure, fuel swelling, hot pressing, and it also includes alternative correlations for stainless steel swelling. Fuel cracking is not included. The output of KRASS includes the radial and axial stress and strain distribution of the fuel and clad as a function of the burn-up. It takes KRASS 11 x 10^2 machine unit seconds on the IBM 360-91 to calculate the fuel element behavior to 15 percent burn-up, with seven axial sections in the fuel column. The results of the calculations indicate that the axial variation of the fuel-clad mechanical interaction greatly depends on the fluence-to-burnup ratio, as well as on the applicable stainless steel swelling correlation. The results also show that transient fuel element behavior studies of the pre-irradiated fuel must make allowance for these differences. At higher linear power ratings the largest fuel-clad mechanical interaction generally occurs in the lower third of the fuel element while at low power ratings, this interaction is largest at the axial midsection. At high fluence-to-burnup ratios, the central axial nodes frequently exhibit gap reopening tendencies.

56561 Method to calculate the influence of gas bubbles in liquid-metal cooled reactors. Malang, S.; Rust, K. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorbauelemente). *Atomwirtsch., Atomtech.;* **21**: No. 12, 579-581(Dec 1976). (In German).

5 figs.; 1 ref.

Under certain operating conditions, the coolant entering the reactor tank of loop-type liquid-metal cooled reactors may contain gas bubbles. Contructional measures help to make sure that most of the gas is separated before entering the fuel zone and flows through the radial blanket. The gas bubbles cause the temperature in the fuel rods to rise. A computer model for the calculation of a two-dimensional, instationary temperature field is presented.

56562 Design correlation for pressure drops in coiled, once-through steam generators. Campolunghi, F.; Cumo, M.; Ferrari, G.; Techy, Z.; Vaccaro, G. (Com Naz Per l'Energ Nucl, Rome, Italy). *Termotecnica (Milan);* **30**: No. 12, 662-670(Dec 1976).

A two-phase drop correlation for once-through, coiled steam generators is suggested on the basis of a set of experimental data. Experimental results are reproduced within a $plus or minus$10% error.

56563 Efficacy of the working media of nuclear power plants with gas-cooled fast reactors and low-temperature utilization of heat to obtain fresh water. Tetel'baum, S.D.; Dyablo, V.V. (Odessa Polytech Inst, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 12, 64-68(Dec 1976). (In Russian).

Changes in the technico-economic indices of installations using different working media in the cycles of nulcear power plants with fast gas-cooled reactors and utilizing low-potential heat for the purposes of water desalination are analyzed. It is shown that the use of a mixture of helium and carbon dioxide gases promises lower costs than the use of carbon dioxide or helium alone.

56564 Experimental study on fast-neutron streaming through a grid-plate shield of a liquid-metal fast breeder reactor. Oka, Y.; Wakabayashi, H.; An, S. (Univ of Tokyo, Tokai-Mura, Ibaraki, Jpn). *Nucl. Technol.;* **31**: No. 3, 287-296(Dec 1976).

Neutron streaming through the holes penetrating the grid-plate shield of a prototype liquid-metal fast breeder reactor was examined. A $sup 3$He spectrometer was employed to measure the transmitted neutron spectrum, while rhodium and indium threshold foils were used to determine the integral flux above specific energies and their spatial distributions in the form of reaction rates. Use was made of the one- and two-dimensional neutron transport codes ANISN and TWOTRAN for evaluation by computation. The reaction rates calculated by an infinite slab model with the ANISN code agree well with the experiments when normalized at the source point where neutrons are incident on the grid-plate shield. This work is important for the development of liquid-metal fast breeder reactors (LMFBRs).

56565 Alloy 800 for liquid-metal fast breeder reactor steam generators. Julien, M. (Fives-Cail Babcock, La Courneuve, France). *Nucl. Technol.;* **31**: No. 3, 367-374(Dec 1976).

Main metallurgical test results that have helped to define the chosen Alloy 800 are presented. Alloy 800 has been already used in the construction of different prototypes, one of which has an output of 45 MW(th) and was tested in the Electricite$prime$ de France (EdF) test station of C.G.V.S. Renardieres. These prototypes, which are made with industrial products (tubes, plates) have demonstrated satisfactory behavior for several thousand hours of service.

56566 Research, development and realization of sectional modular sodium heated steam generator. Dubsek, F. (Vyzkumny Ustav Zavodu Energetickeho Strojirenstvi, Brno (Czechoslovakia)). *Jad. Energ.;* **22**: No. 8, 283-292(Aug 1976). (In Czech).

Modular steam generators are among the promising types of steam generators for nuclear power plants with sodium cooled fast reactors. The experience is summed up which was gained at the First Brno Engineering Plant in project designing, manufacturing and in the trial operation of the steam generator for the BOR-60 nuclear power plant in the USSR. The operation of the generator has proved the correctness of the calculated parameters and promises the wide use of this type of steam generator in nuclear power production.

56567 Method of calculation of detailed power distribution in fuel assemblies. Suzuki, T.; Katsuragi, S. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 7, 348-357(Jul 1976).

A method has been developed that effectively estimates the detailed distribution of power generation in the fuel or blanket assemblies in nuclear reactors. A two-dimensional, one-group diffusion model is applied to a region of homogeneous composition enclosed in a contour devoid of concavity viewed from outside. The diffusion equation is reduced to the form of Helmholtz equation, and a non-homogeneous boundary condition of Dirichlet or Neumann type is given on the contour, using neutron fluxes previously obtained in coarse mesh diffusion criticality calculations covering the whole reactor. This boundary value problem in two-dimensional space is made to yield a solution in the form of a potential due to a single or double layer. The method is applied to a hexagonal cell of a fast reactor. The results of calculation are amply accurate in comparison with the corresponding values from the usual fine-mesh diffusion scheme and with much shorter computing time.

56568 Calculation of basic resonances for acoustic vibration in fast reactors. Bentley, P.G.; Firth, D. (Risley Eng and Mater Lab, Warrington, Engl). *Comput. Struct.;* **6**: No. 3, 187-192(Jun 1976).

The paper concentrates on the numerical calculation of resonances by computer program, and various simple formulae which have proved useful. It shows that acoustic resonances similar to those found in audio acoustics, namely organ pipe and concert hall modes, will be found in fast reactors. The properties of the structure have a moderate effect on the frequencies of organ pipe resonances and a very small effect on the pool resonances. In the first case the wall is approximately a rigid wall and in the second it is approximately a pressure release boundary. Structural resonances are strongly influenced by the liquid mass loading but the acoustic properties of the liquid are not important. 10 refs.

56569 Operational reliability evaluation of fast power reactor cores. Pecha, P. *Nukleon;* No. 4, 3-10(Mar 1976). (In Czech).

The correct choice of limits in designing the principal characteristics of core reliability is discussed. Particular emphasis is placed on temperature limits from which criteria for safe core operation are derived. In view of the random nature of temperature changes, the criteria are of a probability character and may take on different forms dependent on to what extent the design is conservative and respects security demands. The further development is likely to proceed from conventional thermotechnical safety problems to research into fuel pin life.

56570 Elaboration of methods for burn-up determinations of fast reactor fuel. Koch, L. (Europaeisches Institut fuer Transurane, Karlsruhe (BRD)). *J. Radioanal. Chem.;* **32**: No. 2, 357-365(1976). (In German).

4 figs.; 17 refs.; 2 tabs.

The burn up determination of fast reactor fuel is more difficult than that of thermal reactors, because of the greater number of fission products. In fast fluxes each heavy isotope - present in the system - must be treated as a fission source. Because of this reason ^{238}U cannot be used as reference value for the normalization of the isotope concentrations. The isobar fission yields of each fission source were checked to find an appropriate fission monitor. The pre preliminary results indicate that some of the neodymium isotopes would fulfil the requirements. The chemical separation techniques used for the analysis is briefly described, the automation of the method and the data acquisition system are rewieved. An isotope correlation to check the analysis is mentioned.

56571 Containers for radioactive aerosols. Naito, K.; Fukushima, Y.; Ozawa, Y.; Sato, Y.; Minato, A. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-108,193/A/. 20 Mar 1975. 6p. (In Japanese).

Object: To spray coprecipitation material onto sodium generated at the time of failure and aerosol of nuclear fuel material thereby facilitating aggregation and precipitation of the aerosol.

Structure: A sprayer device, which sprays coprecipitation material (activated carbon) adapted to coprecipitate aerosol, is provided in a pit chamber at the upper part of a reactor container. When a sodium leaking failure occurs, a working valve is opened to spray a coprecipitation material within a coprecipitation material tank into the pit chamber through a nozzle, thereby facilitating aggregation and precipitation of burned sodium and aerosol of sodium and aerosol of nuclear fuel material, thus quickly decreasing density of radioactive material within the gases.

56572 Door valve. Goto, T.; Sakaguchi, S.; Horikawa, T.; Honda, N. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-108,195/A/. 19 Mar 1975. 5p. (In Japanese).

Object: To provide a highly durable door valve in which a pressure chamber is provided between a plurality of packings disposed in a shaft seal portion, and pressure gases are supplied thereto to enhance air-tightness of the shaft seal portion. Structure: A door valve provided with a valve driving valve rod extending through a valve casing, the extending-through portion having a plurality of packings disposed thereon, the valve rod driving source side of said packings being provided with a pressure chamber composed of a plurality of plates and a pressure gas supply means in communication with said pressure chamber.

56573 Reactor apparatus. Nemoto, K. (to Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Japanese Patent 1976-101,696/A/. 4 Mar 1975. 3p. (In Japanese).

Object: To employ syphon principles in order to automatically stop leakage of cooling medium with a reactor container during an accident in which a primary coolant system duct cracks or breaks, thereby preventing burn out of the reactor core fuel. Structure: A sodium inlet duct introduced into a reactor from its bottom is held at a level higher than the reactor core, and a concentric depending tube with an upper blind lid is provided on the outerside of the rising tube. Sodium is supplied through these tubes to the bottom of the reactor. When an accident takes place within the duct, sodium flows backward to the outside of the container. However, when the liquid level of sodium is lowered down to the afore-said hole, cover gas is introduced into the duct. As a result, the syphoning effect vanishes to stop the leakage of sodium.

56574 Reactor. Ito, A.; Wakamatsu, M. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-99,79/A/. 28 Feb 1975. 14p. (In Japanese).

Object: To provide a fast breeder which can set with high accuracy the flow rate of coolant passing through each fuel assembly to thereby increase thermal output and to enhance thermal efficiency and safety. Structure: An intermediate low pressure coolant chamber is disposed between an upper low pressure coolant chamber and a high pressure coolant chamber to introduce a coolant from the intermediate low pressure coolant chamber into part of blanket fuel assembly, whereby the quantity of coolant flown into a clearance between the inner surface of connections and the outer surface of the entrance nozzle may be maintained approximately constant, and as a consequence, the flow rate of coolant within the core fuel assembly can be controlled with high accuracy only by varying the size and the number of introducing openings in the entrance nozzle and the quantity of leakage from the contact portion can be restrained.

56575 Reactor. Ito, A. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-99,797/A/. 28 Feb 1975. 7p. (In Japanese).

Object: To enable a coolant to be passed at flow rate as desired through each of fuel assemblies thereby enhancing thermal efficiency and safety of a reactor. Structure: A mechanism for introducing a coolant so that the coolant fed into a high pressure coolant chamber may be flown into a communication pipe through a hole in the communication pipe and thence passing through a clearance and the hole into a horn pipe. The quantity of coolant flown-in is determined depending upon pressure loss in the clearance. The large-diameter portion formed at the foremost end of a shaft constitutes a part of walls of the lower low pressure coolant chamber so that a force corresponding to a differential between pressure in the high pressure coolant chamber and pressure in the lower coolant chamber is downwardly exerted upon the large-diameter portion to prevent levitation of the core fuel assembly.

56576 Apparatus for cooling a fuel replacing cell in a reactor. Sato, M. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-95,598/A/. 19 Feb 1975. 4p. (In Japanese).

Object: To allow inert gases within a fuel replacing cell in a liquid-metal cooled reactor to be heat-exchanged with gases cooled by a cooler through a cell liner, thus simplifying shielding constructions and reducing space used for arrangement. Structure: The apparatus comprises a plurality of cell gas flow channels arranged so that inert gases circulated within the fuel replacing cell (hot cell) may be centrally moved up, moved down internally of the cell and emitted onto the floor of the cell, and a plurality of cooling air flow channels for flowing air placed in contact externally and cooled through the cell gas flow channels and the cell liner of the fuel replacing cell.

56577 Fuel assembly in a reactor. Sakagami, M.; Takeda, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-86,688/A/. 29 Jan 1975. 4p. (In Japanese).

Object: To prevent a shroud, which constitutes a fuel assembly in a fast breeder, from being deformed due to swelling phenomenon. Structure: A shroud is made of more than two kinds of materials (for example, such as stainless 316 steel, improved 316 steel in which niobium or titanium or the like is added to the stainless 316, or nickel base alloy PE-16, etc.) different in effect of radiation damage (that is, the amount of swelling) caused by the neutron irradiation within the reactor.

56578 Core components for a sodium cooling fast breeder. Uematsu, K.; Kamimura, K.; Himeno, Y.; Kaneko, H.; Ishibashi, E. (to Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Japanese Patent 1976-86,695/A/. 28 Jan 1975. 4p. (In Japanese).

Object: To perform surface treatment of members for constituting a sodium cooling fast breeder to thereby prevent pressure loss or the like of a flow of sodium, thus avoiding a decrease in performance of the reactor. Structure: Members such as fuel cladding tubes, an assembly, spacers, shielding body, reflector, etc., which are used where liquid sodium flows in a fast breeder, are subjected to pre-surface treatment so as to have their surface roughness in the range from about 2 to 10 microns.

56579 Electromagnetic induction pump. Le Frere, J.P. (Groupement pour les Activites Atomiques et Avancees (GAAA), 92 - Le Plessis-Robinson (France)); Thevenin, Michel (Societe Technique pour l'Energie Atomique (Technicatome), Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). (to CEA, 75 - Paris (France)). French Patent 2,293,101/A/. 27 Nov 1974. 9p. (In French).

The electromagnetic induction pump described includes an annular circulation area for the liquid medium to be pumped, in which is fitted a tubular magnetic core, a removable stator generally cylindrical in shape around this annular area on a level with the magnetic core, a protective casing fitted coaxially to the assembly. The return of the fluid is carried out through a central pipe fixed by one of its ends to an external pipe and by the opposite end to the protective casing. It can be employed in plants for purifying the primary sodium of fast nuclear reactors.

56580 (NP-tr—1980) **Experimental studies on sodium fires application to reactors.** Fruchard, Y.; Colome, J.; Berlin, M.; Cercy, J.; Duco, J.; Duverger de Cuy, G.; Malet, J.C.; Fourest, B. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France); Compagnie d'Ingenierie pour les Reacteurs au Sodium (CIRNA), Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). [nd]. Translation of French report. 26p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The Department of Nuclear Safety of the Atomic Energy Commission has completed numerous tests at the Cadarache Center in order to: study the different kinds of sodium fires which might occur in case of a leak; ascertain the risks and damage which such fires could cause in nuclear installations; and perfect methods for extinguishing them. Fires on the surface of sodium pools were studied in a 400 m^3 caisson of reinforced concrete which can operate as a sealed enclosure or as a ventilated area. The initial temperature of the sodium was varied (from 140°C to 840°C), the surface of the combustion pan was varied (1 to 4 m^2), and the mass of sodium was varied (15 to 300 kg). The findings concern the hazards of inflammation at low temperatures, the risk of propagation, the mechanics of combustion and the kinetics of the fires, the thermal effect on containments and structures, and the behavior of sodium oxide aerosols.

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 56742

56581 (DOCKET-50586—1) **Perryman Nuclear Power Plant. Site suitability--site safety report, volume I: chapters-sections 1.1, 1.2, 1.4, 1.6; 2.1, 2.2.** (Baltimore Gas and Electric Co., Md. (USA)). 1 Jul 1977. vp.

A site suitability report is submitted in support of the Baltimore Gas and Electric Company application for a limited early site review of a potential nuclear power plant. The Perryman Nuclear Power Plant site is located in northeastern Maryland on an arm of the Chesapeake Bay estuary approximately 17 miles east—northeast of Baltimore. The proposed plant is a two-unit light water reactor with a 3800 MW(t) power level for each unit. General descriptions

of the site geography, demography, nearby facilities, and meteorology are presented. (HDR)

56582 (NUREG—0199) **Environmental planning and the siting of nuclear facilities: the integration of water, air, coastal, and comprehensive planning into the nuclear siting process. Improving regulatory effectiveness in federal/state siting actions.** Noble, J.B.; Epting, J.T.; Blumm, M.C.; Ackerman, S.; Laist, D.W. (Center for Natural Areas, Washington, D.C. (USA)). Feb 1977. 209p. NTIS $7.75.

The National Environmental Policy Act, the Coastal Zone Management Act, the Federal Water Pollution Control Act, the Clean Air Act Amendments, and the Housing and Urban 701 Comprehensive Planning Assistance Program are discussed in relation to the planning and siting of nuclear facilities.

56583 (NUREG—0292) **Nuclear power plant licensing: opportunities for improvement.** (Nuclear Regulatory Commission, Washington, D.C. (USA)). Jun 1977. 109p. Dep. NTIS, PC A06/MF A01.

On April 20, 1977, the Commission directed that recently completed licensing actions be reviewed by the staff for the purpose of identifying ways to improve the effectiveness and efficiency of NRC nuclear power plant licensing activities. This report summarizes the results of a study undertaken by an internal ad hoc Study Group established in response to that directive. The Study Group limited its considerations to safety and environmental review activities. The background, scope, assumptions and objectives of the study are discussed. A prime assumption of this study was that improvements in the efficiency should not be permitted to reduce the current quality achieved in the licensing process. This consideration underlies the conclusions and recommendations of the study.

56584 (NUREG/PRDI—77/4) **Power Reactor Docket Information.** (Nuclear Regulatory Commission, Washington, D.C. (USA)). Apr 1977. 55p. TIC $3.70.

Citations and subject indexing to the documentation associated with civilian nuclear power plants are presented. This material is that which is submitted to the U.S. Nuclear Regulatory Commission in support of applications for construction and operating licenses. Citations are listed by Docket number in accession number sequence. The Table of Contents is arranged both by Docket number and by nuclear power plant name.

56585 (PB—265676) **Report to Congress on abnormal occurrences, July—September 1976. Quarterly report, Jul—Sep 1976.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Management Information and Program Control). Mar 1977. 25p. (NUREG—0090-5). NTIS PC A02/MF A01.

See also PB—258749.

Section 208 of the Energy Reorganization Act of 1974, identifies an abnormal occurrence as an unscheduled incident or event which the Nuclear Regulatory Commission determines to be significant from the standpoint of public health or safety and requires a quarterly report of such events to be made to Congress. This report, the sixth in the series, covers the period from July 1 to September 30, 1976. The NRC has determined that during this period: (1) There were three abnormal occurrences at the 62 nuclear power plants licensed to operate. One involved the loss of AC power to safety-related equipment. The second involved a nuclear core power distribution anomaly. The third is a generic event pertaining to steam generator tube integrity. The incidents had no actual impact on public health or safety. (2) There was one abnormal occurrence at fuel cycle facilities (other than nuclear power plants). The event involved an accumulated nuclear material inventory anomaly. (3) There were two abnormal occurrences at other licensee facilities. Both occurrences involved incidents of occupational whole body exposures to radiography personnel. This report also contains information updating a previously reported abnormal occurrence.

56586 (PB—265794) **Nuclear power plant operating experience, 1974—1975.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Management Information and Program Control). Apr 1977. 506p. (NUREG—0227). NTIS PC A22/MF A01.

The operating experience of U.S. nuclear power plants in commercial operation during 1974 and 1975 is summarized. Power generation statistics, plant outages, reportable occurrences, fuel element performance, radiation exposure and radioactive effluent releases for each plant are presented. Summary highlights of these areas are discussed. The 1974 data covers 40 plants--17 boiling water reactor plants and 23 pressurized water reactor plants; while the 1975 data includes 51 plants--23 boiling water reactor plants and 28 pressurized water reactor plants.

56587 (PGE—8003(Rev.1)(Att.2)) **Nuclear projects quality assurance program for design, construction, and preoperational testing. Revision 1. Attachment 2. Responses to NRC request for additional information for PGE topical report, PGE—8003.** (Portland General Electric Co., Oreg. (USA)). Apr 1977. vp. General Electric Co., Portland, OR.

The Quality Assurance Program of PGE for safety-related activities pertaining to the design, construction, and preoperational testing of nuclear power plants is presented.

56588 **Radiological criteria for release of land and for decommissioning facilities.** Conti, E.F.; Erickson, P.B. (Nuclear Regulatory Commission, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 120(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56589 **Regulatory issues in nuclear fuel accounting and rate making.** Lindsay, W.W. (Federal Power Commission, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 309(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

ECONOMICS

REFER ALSO TO CITATION(S) 56563, 56741

56590 (CONF-7606151—) **Economic viability of nuclear energy. A seminar for members of Congress and their staffs.** (Scientists' Inst. for Public Information, New York (USA)). 1976. 71p. Institute for Public Information, New York, NY.

From Seminar on the economic viability of nuclear energy; Washington, District of Columbia, United States of America (USA) (7 Jun 1976).

A panel discussion on the economic viability of nuclear power is covered. The panelists included Barry Commoner, Lewis Perl, David Comey, and Vincent S. Boyer.

CONSTRUCTION AND OPERATION

56591 (PB—264467) **Power plant productivity. Analysis report.** Knecht, P.D.; Prideaux, D.L.; Zahner, R.R. (Nuclear Services Corp., Campbell, Calif. (USA)). 28 Nov 1975. Contract FEA-CO-05-50302-00. 153p. NTIS PC A08/MF A01.

See also PB—264468.

The productivity of four large central station electric power plants, two coal-fired and two nuclear, is analyzed. The investigative effort included a comparison of the four stations to determine what aspects of operations, maintenance, organizations, or equipment operation and repair cause one unit to have a better productivity than another. Conclusions were drawn to identify the underlying causes of low productivity and recommendations were developed for improving plant productivity.

56592 (PB—264468) **Productivity improvement action plan.** Knecht, P.D.; Prideaux, D.L.; Zahner, R.R. (Nuclear Services Corp., Campbell, Calif. (USA)). 28 Nov 1975. Contract FEA-CO-05-50302-00. 95p. NTIS PC A05/MF A01.

See also PB—264467.

The productivity of four large central station electric power plants is analyzed. Aspects of operation, maintenance, organization, or equipment operation and repair, that cause one unit to have better productivity than another are determined. Conclusions identifying the underlying causes of lost productivity and recommendations for improving plant productivity are made.

56593 (PB—264564) **Power plant productivity: an assessment of outages at two coal-fired and two nuclear plants.** (Trident Engineering Associates, Inc., Annapolis, Md. (USA)). 17 Nov 1975. Contract FEA-CO-05-50802-00. 225p. NTIS PC A10/MF A01.

The results of a study which assessed the operation maintenance, management and manning of two large fossil-fueled electrical generating units and two large nuclear-fueled units are presented. The two units to be examined in each category were to consist of one unit with a history of high reliability, and one unit with a history of lesser reliability. The objective of the study was to find, insofar as possible, the differences between high and low reliability in similar plants; and through an understanding of these 'root' causes, to make recommendations having the potential to produce a meaningful increase in the productivity of lower performing generating units.

56594 (PB—264565) **Action Plan for improving power plant productivity.** (Trident Engineering Associates, Inc., Annapolis, Md. (USA)). 17 Dec 1975. Contract FEA-CO-05-50802-00. 56p. NTIS PC A04/MF A01.

See also PB—264564.

The operation, maintenance management, and manning of two large fossil-fueled electrical generating units and two large nuclear-fueled units are evaluated. The two units to be examined in each category were to consist of one unit with a recent history of above average reliability and one unit with a history of lesser

reliability, as measured by available industry statistics. The objective of the study was to determine the underlying causes of high and low reliability in comparable plants; and to make recommendations having the potential to produce a meaningful increase in the productivity of lower performing generating units. This Action Plan is derived from information developed during the course of the study. The purpose of this Action Plan is to provide visibility to the industry as a whole of some methods which can be used as a basis for improving plant reliability, as well as to provide a guideline plan for the improvement of the reliability of the particular plant selected.

56595 Advanced methodology and systems for power plant pathology. Thie, J.A. (Consultant, Barrington, IL); Sanathanan, C.K.; McCormick, B.H.; Chang, S.K. *Trans. Am. Nucl. Soc.;* **26**: 91(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

FUEL CYCLE

REFER ALSO TO CITATION(S) 55890, 55891, 55892, 55894, 55941, 55943, 55946, 56546

56596 Economic computations in the fuel cycle. Hang, D.F. (Univ. of Illinois, Urbana). *Trans. Am. Nucl. Soc.;* **26**: 89(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56597 Educational aspects of reactor calculations for fuel management. Fulford, P.J. (Purdue Univ., West Lafayette, IN). *Trans. Am. Nucl. Soc.;* **26**: 89-90(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56598 Benefit-cost analysis in the nuclear fuel cycle. Kneese, A.V. (Univ. of New Mexico, Albuquerque). *Trans. Am. Nucl. Soc.;* **26**: 134-135(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56599 Fuzzy set theoretic approach to systems analysis. Shinohara, Y. (Japan Atomic Energy Research Inst., Ibaraki-ken). *Trans. Am. Nucl. Soc.;* **26**: 265-266(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56600 Impact of thermal near-breeders on uranium utilization. Chang, Y.I.; Till, C.E. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 282-283(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56601 Alternative fuel cycle for Nuclear Energy Centers. Matzie, R.A.; Rec, J.R.; Terney, A.N. (Combustion Engineering, Inc., Windsor, CT). *Trans. Am. Nucl. Soc.;* **26**: 306-307(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56602 Interface between fuel management and nuclear fuel accounting. Steyn, J.J. (NUS Corp., Rockville, MD). *Trans. Am. Nucl. Soc.;* **26**: 308(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56603 Financing and accounting for nuclear fuel: a problem of unknown certainty. Swanson, R. (Arthur Andersen and Co., Columbus, OH). *Trans. Am. Nucl. Soc.;* **26**: 309(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56604 Nuclear fuel accounting practice at Duke Power Company. Stimart, W.R. (Duke Power Co., Charlotte, NC). *Trans. Am. Nucl. Soc.;* **26**: 310(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56605 Nuclear inventory and management system (NIMS): a program for nuclear fuels accounting. Pitts, O.P. Jr.; Ratliff, J.R. (Tennessee Valley Authority, Chattanooga). *Trans. Am. Nucl. Soc.;* **26**: 310-312(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56606 Nuclear fuel cycle: (4) the reactors. Farmer, A.A. (UKAEA, React Group, Risley, Warrington, Engl). *J. Inst. Fuel;* **50**: No. 402, 33-40(Mar 1977).

The main fission reactors that use the nuclear fuel described in earlier papers are described briefly and their relative merits indicated. The author concentrates on those reactor types that are either in commercial use or that are expected to be in commercial use before the 1990s. Other possible types are mentioned briefly but discussion of the fusion reactor is specifically excluded. 3 refs.

PROCESS HEAT REACTORS

REFER ALSO TO CITATION(S) 55590, 55593, 56563, 57139

56607 (CONF-760503—P1, pp 427-430) **Application of boiling liquid metals in industrial processes.** Kottowski, H.M.; Savatteri, C.; Mol, M.; Fiebelmann, P. (Euratom, Ispra, Italy). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

The successful development of coated particle fuel and of special graphites for the structural components of VHTR-cores has opened up the possibility of an economical nuclear heat source to provide temperatures in excess of 1000°C as "process heat application". In order to exploit this temperature potential the heat has to be transferred to the appropriate chemical processes and there is little doubt that the only practical way of achieving this on a large scale is by the use of intermediate heat exchanger systems. The aim of the paper is to exhibit a technological possibility, both to substitute the secondary circuit of the sodium cooled reactors and to transfer the heat from the VHTR to the chemical process plant which satisfies the safety requirements and demonstrates technological advantages.

56608 (CONF-770403—15) **Studies of a small PWR for onsite industrial power.** Klepper, O.H.; Smith, W.R. (Oak Ridge National Lab., Tenn. (USA); Babcock and Wilcox Co., Lynchburg, Va. (USA)). 19 Apr 1977. Contract W-7405-ENG-26. 21p. MF A01.

From 39. annual meeting of the American Power Conference; Chicago, Illinois, United States of America (USA) (18 Apr 1977).

Information on the use of a 300 to 400 MW(t) PWR type reactor for industrial applications is presented concerning the potential market, reliability considerations, reactor plant description, construction techniques, comparison between nuclear and fossil-fired process steam costs, alternative fossil-fired steam supplies, and industrial application.

56609 Germany plans process heat schemes for HTGR. Jeffs, E. *Energy Int.;* **14**: No. 5, 37-40(May 1977).

Plans for the use of HTGR heat sources in coal gasification techniques based on methane reformation are discussed.

56610 Combined system for power and desalinated water production by nuclear power stations. Marena, M.; Nordio, M.; Senis, R. (Ente Naz per l'Energ Elettr, Rome, Italy). *Energ. Elettr.;* **53**: No. 12, 634-649(Dec 1976). (In Italian).

After having illustrated a few thermodynamic considerations on desalting, the paper presents a systematic survey of the main processes, showing their features from the viewpoint of thermodynamic irreversibilities. Then, the thermodynamic advantages araising from coupling a thermoelectric plant to a desalting system are examined and the variables involved in the design are discussed, while showing the method followed for the sizing of a combined system for the power and desalted water supply. Finally, some numerical evaluations of the method applied to a dual system involving a 1000 MW$sub e$ nuclear power station, ENEL standard type, are presented, and the incidence of power on desalted water cost is calculated. 18 refs.

56611 Principles of nuclear district heating. Melent'ev, L.A. (Heat Eng Inst, Acad of Sci of the USSR). *Teploenergetika (Moscow);* No. 11, 6-9(Nov 1976). (In Russian).

It is argued that nuclear power plants have to be used not only to produce electric power but also for industrial and district heating purposes. It is suggested that, in the long term, about 50% of the capacities of nuclear reactors in the USSR should be used for electric power production and 50% for heating purposes. The most efficient type of nuclear power plants is considered to be a mixed-condensing-and-district heating type. Selection of district heating turbines, of optimal thermal diagrams of technological steam and hot water piping systems, of construction sites, and reactor design problems are discussed.

56612 Plant for producing hydrogen by utilizing the thermal energy generated in a gas-cooled high-temperature reactor. Baumgaertner, H.; Barchewitz, E. (to Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.)). German(FRG) Patent 2,455,508/A/. 26 May 1976. 19p. (In German).

2 figs.

The invention concerns the design of equipment of a plant for producing hydrogen by utilizing the thermal energy generated in a gas-cooled high-temperature reactor. This energy is supplied by the coolant gas to a number of steam reformers and to steam generators connected in series with those. According to the invention, the high-temperature nuclear reactor, the cracking tube-furnaces as will as the recuperative heat exchangers connected with them, and the steam generators are housed within recesses of a common prestressed concrete pressure vessel. The claims refer to the guiding of the gas ducts (coaxial gas flow) and the geometrical arrangement of the internals in the pressure vessel with respect to each other.

56613 High temperature materials requirements in reforming of gaseous hydrocarbons with HTR heat. Niessen, H.F.; Kugeler, K.; Kugeler, M. (Kernforschungsanlage Juelich, Ger.). *Rev. Int. Hautes Temp. Refract.;* **13**: No. 4, 204-211(1976).

The paper discusses the design of a HTR (high-temperature reactor) helium-heater steam reformer under construction for a projected nuclear process heat prototype plant for coal gasification. The requirements for the tube material for this reformer are dealt with in detail. 16 refs.

56614 Method for the production of hydrogen by water splitting. Schulten, R.; Barnert, H. (to Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). German(FRG) Patent 2,365,120/A/. 10 Jul 1975. 18p. (In German).

1 fig.

In the first process step of a thermochemical cycle process, steam and sulphur dioxide are reacted as a gas mixture in a certain volume ratio with an oxide of one of the metals manganese, iron, cobalt, nickel, zinc or cadmium to form a metal sulphate and to release hydrogen in the temperature region of 200 to 400°C. The hydrogen is separated off according to known methods. In a second process step, the metal sulphate is heated up to a temperature region of 700-1,000°C for decomposition and formation of metal oxide, sulphur dioxide and oxygen. The oxygen gas is separated from the sulphur dioxide gas using known methods. The claims deal with the steam-sulphur dioxide volume ratio (preferably 5:2), the temperature regions depending on the sort of metal, as well as with the nature of the metal oxide and its carrier.

NUCLEAR REACTOR TECHNOLOGY

56615 Process instrumentation measurements for nuclear engineering laboratories. Diaz, N.J. (Univ. of Florida, Gainesville). *Trans. Am. Nucl. Soc.;* **26**: 94(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56616 Role of nuclear laboratory courses at Purdue University. Clikeman, F.M. (Purdue Univ., West Lafayette, IN). *Trans. Am. Nucl. Soc.;* **26**: 94-95(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56617 Development of the Nuclear Engineering Laboratory of Ecole Polytechnique. Boisvert, J.; Tapucu, A.; Amyot, L. (Institut de Genie Nucleaire, Montreal). *Trans. Am. Nucl. Soc.;* **26**: 95-96(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56618 Expanding nuclear engineering student knowledge horizons using the laboratory. Roberts, D.M. (Iowa State Univ., Ames). *Trans. Am. Nucl. Soc.;* **26**: 96-97(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56619 Computer-based data acquisition system for a multistation teaching laboratory. Knoll, G.F. (Univ. of Michigan, Ann Arbor). *Trans. Am. Nucl. Soc.;* **26**: 97(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56620 Computer modules in the nuclear engineering laboratory. Onega, R.J. (Virginia Polytechnic Inst. and State Univ., Blacksburg); Parkinson, T.F.; Smith, P.R. *Trans. Am. Nucl. Soc.;* **26**: 97-98(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56621 Incorporation of commercial reactor codes into a nuclear engineering course. Mosteller, R.D. (Catholic Univ. of America, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 99(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56622 Code to assist in teaching nuclear fuel management. Morris, C.J. (Battelle Pacific Northwest Lab., Richland, WA); Wescott, R.I.; Forbes, I.A. *Trans. Am. Nucl. Soc.;* **26**: 99-100(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56623 Teaching project management as part of international technology. Kanter, M.A. (Argonne National Lab., IL); O'Brien, F.D. *Trans. Am. Nucl. Soc.;* **26**: 101(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56624 Cooperative education at one utility. Wittke, D.D. (Omaha Public Power District). *Trans. Am. Nucl. Soc.;* **26**: 102(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56625 Cooperative nuclear engineering-utility programs at North Carolina State University. Stam, E.; Bohannon, J.R.; Elleman, T.S. (North Carolina State Univ., Raleigh). *Trans. Am. Nucl. Soc.;* **26**: 102-103(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56626 Interaction between utilites and the university. Hornyik, K.; Ringle, J.C.; Spinrad, B.I. (Oregon State Univ., Corvallis). *Trans. Am. Nucl. Soc.;* **26**: 103(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56627 Industrial internship program in nuclear engineering education. Trojan, O.A. (Atomic Energy of Canada Ltd., Ontario); Meneley, D.A.; Harms, A.A. *Trans. Am. Nucl. Soc.;* **26**: 103-104(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56628 Development of the undergraduate nuclear engineering co-op program at Cincinnati. Christenson, J.M.; Bunce, W.R. (Univ. of Cincinnati, OH). *Trans. Am. Nucl. Soc.;* **26**: 104(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56629 Three year's experience with a graduate nuclear engineering co-op program. Meem, J.L. (Univ. of Virginia, Charlottesville). *Trans. Am. Nucl. Soc.;* **26**: 105(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56630 Transactions of the Iran conference on the transfer of nuclear technology held April 10—14, 1977, in Persepolis/Shiraz, Iran. Farmakes, R. (ed.). Hinsdale, IL; American Nuclear Society, Inc. (1977). 158p.

Summaries of papers on the transfer of nuclear technology by national and international organizations are presented. Each summary was processed separately for the data base. (HDR)

56631 IAEA experience in the transfer of nuclear technology. Eklund, S. (International Atomic Energy Agency, Vienna). *Trans. Am. Nucl. Soc., Suppl.;* **25**: No. 1, 1(1977).

From Iran conference on the transfer of nuclear technology; Persepolis/Shiraz, Iran (10 Apr 1977).

56632 Experience in transfer of nuclear technology. Sethna, H.N. (Atomic Energy Commission, Bombay). *Trans. Am. Nucl. Soc., Suppl.;* **25**: No. 1, 1-2(1977).
From Iran conference on the transfer of nuclear technology; Persepolis/Shiraz, Iran (10 Apr 1977).

56633 Technology transfer: its contribution to the Canadian nuclear industry. Perryman, E.C.W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). *Trans. Am. Nucl. Soc., Suppl.;* **25**: No. 1, 2(1977).
From Iran conference on the transfer of nuclear technology; Persepolis/Shiraz, Iran (10 Apr 1977).

56634 U.S. experience in the transfer of nuclear technology. Roberts, R.W. (Energy Research and Development Administration, Washington, DC). *Trans. Am. Nucl. Soc., Suppl.;* **25**: No. 1, 2-3(1977).
From Iran conference on the transfer of nuclear technology; Persepolis/Shiraz, Iran (10 Apr 1977).

56635 Experience in transfer of nuclear technology. Beckurts, K.H. (Kernforschungsanlage, Juelich, Ger.). *Trans. Am. Nucl. Soc., Suppl.;* **25**: No. 1, 3-4(1977).
From Iran conference on the transfer of nuclear technology; Persepolis/Shiraz, Iran (10 Apr 1977).

56636 Nuclear technology experience acquired by Argentina. Quihillalt, O.J.; Grasso, H.O. (Comision Nacional de Energia Atomica, Buenos Aires). *Trans. Am. Nucl. Soc., Suppl.;* **25**: No. 1, 4(1977).
From Iran conference on the transfer of nuclear technology; Persepolis/Shiraz, Iran (10 Apr 1977).

56637 Transfer of technology in the French—Iranian study for a nuclear research center in Iran. Pecqueur, M. (Commissariat a l'Energie Atomique, Paris). *Trans. Am. Nucl. Soc., Suppl.;* **25**: No. 1, 5-6(1977).
From Iran conference on the transfer of nuclear technology; Persepolis/Shiraz, Iran (10 Apr 1977).

THEORY AND CALCULATION

56638 (JAERI-M—6597) Transient heat transfer in turbulent flow with time-dependent heat input. Kawamura, H. (Japan Atomic Energy Research Inst., Tokyo). Jun 1976. 21p. Dep. NTIS (US Sales Only), PC A02/MF A01.
Transient variation of the heat transfer coefficient is involved in accident analysis of a power reactor and thermal design of a pulse reactor. In these cases, however, the heat transfer coefficient is assumed to be equal to the steady-state one. Validity of this 'quasi-static assumption' is examined. The transient energy equation is solved numerically for turbulent annular flow. Variations of the heater temperature and the heat transfer coefficient are obtained in stepwise increase and decrease of the heat input. Variation of the heater temperature is obtained with the quasi-static assumption. The quasi-static assumption is valid if the wall heat capacity is large compared with that of the effective thermal boundary layer in the fluid. Applied in a pulse reactor, the quasi-static assumption results in a higher fuel surface temperature during pulse heating when the gap is filled with sodium.

56639 Critical heat flux: a review of recent publications. Marinelli, V. (Comitato Nazionale per l'Energia Nucleare, Casaccia, Italy). *Nucl. Technol.;* **34**: No. 2, 135-171(Jul 1977).
Although much effort has been devoted to the subject of critical heat flux (CHF) during the last 20 years, the design correlations for CHF predictions in tubes, annuli, and rod bundles are still empirical and generally apply only to restricted ranges of parameters. Recently, experimental data on CHF large test sections have been obtained both in steam generators and reactor geometry. A survey of these new data and correlations gives a general picture of the state-of-the-art, linking the new and old results. Existing theoretical analyses stress the importance for future work. Additional experimental work is needed to optimize rod bundle correlations and to extend the validity of correlations to wider ranges and to unusual geometries. The indirect heating problem is not well understood, and continued efforts in theoretical analyses are needed.

56640 Generator of reactivity functions. Porto, J. (Comision Nacional de Energia Atomica, Buenos Aires). *Nucl. Technol.;* **34**: No. 2, 172-178(Jul 1977).
Time-dependent reactivities of many kinds are useful for the analysis of neutron kinetics, such as the study of reactor parameters, neutron wave propagation, or any other specific evolution of the reactor in time. This is done by imposing the time function directly on a cadmium rod and measuring the neutron flux. Two experiments were performed: In the first one, the reactivity function required for a sinusoidal output was generated with all its parameters in agreement with the previous calculation. In the second experiment, a parameter was slightly altered. Both cases were analyzed, and their results agreed with calculations based on the point reactor model.

56641 Solution of the finite element diffusion and P_1 equations by iteration. Tomlinson, E.T. (Oak Ridge National Lab., TN); Robinson, J.C. *Nucl. Sci. Eng.;* **63**: No. 2, 167-178(Jun 1977).
A method is developed for obtaining solutions to the Boltzmann neutron transport equation on irregular triangular grids with nonorthogonal boundaries and anisotropic scattering. A functional is developed from the canonical form of the multigroup transport equation. The angular variable is then removed by expanding the functional in spherical harmonics, retaining only the first two flux moments and limiting the scattering to be linearly anisotropic. The finite element method is then implemented using quadratic Lagrange-type interpolating polynomials to span the spatial domain. The resultant set of coupled linear equations is then solved iteratively using the block successive over-relaxation method. A number of numerical experiments are performed to evaluate the performance of the proposed method. The results are compared to the results obtained by various established methods. In all cases, agreement is excellent.

56642 Exponential supplementary equations for S/sub N/ methods: the one-dimensional case. Barbucci, P.; Di Pasquantonio, F. (Centro di Ricerca Termica e Nucleare, Milan). *Nucl. Sci. Eng.;* **63**: No. 2, 179-187(Jun 1977).
The use of supplementary exponential equations to solve the transport equation by means of the discrete ordinate method has been studied. It is shown that the set of final equations so obtained can be easily and quickly solved on the computer using the same iterative procedure employed in standard S/sub N/ codes. The new method is implemented on ANISN and DOT-III codes. This work refers only to the one-dimensional case. Extensive numerical experiments for neutrons and gamma rays showed that the exponential scheme increases the convergence rate of the iterative procedure and always overestimates the "reference solution" by very small amounts for the finest mesh size and by reasonable amounts for the largest mesh size. For its own structure, the exponential method always gives positive angular fluxes without any adjustment techniques provided the source is non-negative.

56643 Laminar heat transfer data with a step-varying wall heat flux. Reisman, O.I. (New Jersey Inst. of Tech., Newark); Parker, R.O. *Nucl. Sci. Eng.;* **63**: No. 2, 188-191(Jun 1977).
In 1958 Siegel derived a thermal-entry-length integral solution for laminar flow in circular tubes with an arbitrary wall heat flux. From this a solution for a step-varying flux is derived. The objective of this research was to obtain experimental data to verify the accuracy of the above solution. The steps used were a good approximation of the sinusoidal heat flux, which exists along the cooling tube in nuclear reactors. The experimental results fell above the theoretical solution, the average difference being 10.9 percent. Thus, the step-varying wall heat flux solution may be used for the design of cooling systems within that uncertainty.

56644 Wigner-type continuous slowing down theory for the fast-neutron spectrum. Yamamura, Y.; Sekiya, T. (Okayama Coll., Japan). *Nucl. Sci. Eng.;* **63**: No. 2, 213-217(Jun 1977).
The Wigner-type continuous slowing down theory is derived from the physical point of view, considering the neutron balance in lethargy space, and is applied to the calculation of neutron spectra in fast-reactor compositions, where the moderating effect of inelastic scattering is very important. The present theory corresponds to the macroscopic representation of the moderating process of neutrons.

56645 Discrete neutron decay constants above the Corngold limit for infinite slabs. Sjostrand, N.G. (Chalmers Univ. of Tech., Goteborg). *Nucl. Sci. Eng.;* **63**: No. 2, 217-218(Jun 1977).
According to current ideas, there cannot exist any discrete time decay constants above the Corngold limit for unbounded media. Simple arguments are put forward to show that the decay constants of the odd-harmonic modes in an infinite slab may exceed the Corngold limit.

56646 Fast reactor transfer functions with special reference to the nonlinearities and the spatial dependence of the heat transfer process. Caldarola, L.; Ferranti, P.; Mitzel, F. (Kernforschungzent Karlsruhe Inst fuer Reaktorentwickl, Ger.). *Nucl. Technol.;* **31**: No. 3, 306-318(Dec 1976).
A computer program for the calculation of reactor transfer functions has been written and tested. The model used for the temperature feedbacks differs from previous models because it accounts not only for heat propagation and heat transport effects but also for effects due to the nonlinearities of thermal parameters, such

as the fuel thermal conductivity, the fuel specific heat capacity, and the heat transfer coefficient of the gap between fuel and cladding. Transfer functions are evaluated by making use of analytical methods. Numerical results show that physical changes in the gap during power oscillations will have an important effect on some particular transfer functions. This result is important if one wants to evaluate the gap heat transfer coefficient from power oscillation experiments.

56647 Temperature increase in the contact of elements with internal heating at high heat flux densities. Frass, F. (Technische Univ., Vienna (Austria). Inst. fuer Technische Waermelehre). *Waerme;* **82**: No. 5, 89-93(Oct 1976). (In German).

8 figs.; 4 refs.

If two bodies with internal heating (e.g. two reactor fuel rods) touch at one point, the surface temperature at this point will be higher than elsewhere. This phenomenon is studied on two water-cooled cylinders with crossed axes which are in contact with each other.

56648 Improved nucleate boiling design equation. Basu, D.K.; Pinder, K.L. (British Columbia Univ., Vancouver (Canada). Dept. of Chemical Engineering). *Indian J. Technol.;* **14**: No. 9, 421-425(Sep 1976).

26 refs.

The effect of varying ΔT, the primary variable, on the value of heat transfer coefficient (h) in nucleate boiling is discussed. The three-parameter quadratic equation, $h=P_1 + P_2(\Delta T) + P_3(\Delta T)^2$ (where the constants, P_1,P_2,P_3 are functions of pressure, liquid properties and surface properties of the heater) is suggested. Ten sets of data at atmospheric pressure from six different workers and two more sets for pressure variation have been tested. The above quadratic equation fits the experimental data better than the existing two-parameter power relation, h=C(ΔT)sup(n) (where C is constant). The values of the three coeffcients in the quadratic equations are dependent on pressure, liquid properties and surface properties. A generalized empirical equation has been derived, which fits the selected pressure data well.

56649 Measurement of space dependent angular thermal neutron spectra in natural uranium-light water slab. Akino, F.; Kaneko, Y.; Kitadate, K.; Kurokawa, R. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 8, 397-407(Aug 1976).

Space dependent 0^0 angular thermal neutron spectra were measured by time-of-flight method at several positions in a spectrum source, which is a single natural uranium plate sandwiched between two layers of pure water. Theoretical analysis was performed by means of multigroup discrete S_8 method, using Haywood's model for the scattering of thermal neutrons. Fairly good agreement was observed between experiment and theory. The experiment proved that; (1) The Haywoods model is valid for describing the thermal neutron spectra in heterogeneous multiplying media like the present spectrum source, under the condition that anisotropies present in the densities of either neutron scattering or the slowing-down of source neutrons to the thermal neutrons is taken into consideration. The discrepancy between the measured and calculated spectra is very small, and the error induced therefrom in the neutron absorption of ^{238}U is below 3%. (2) The spatial distribution of the source neutrons requires to be taken into consideration, particularly in the case of thermal neutron spectra in the light water region surrounding the natural uranium plate.

56650 Improved response matrix method and its verification by one-dimensional analysis on fast reactors. Takeda, T.; Azekura, K. (Hitachi Ltd., Kawasaki, Kanagawa (Japan). Atomic Energy Research Lab.). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 8, 408-412(Aug 1976).

The current response matrix method based on isotropic (P_0) neutron angular distribution has been improved by effectively including a linearly anisotropic (P_1) angular distribution. The proposed method does not take into account the P_1 component directly, but it includes the effect of this component through consideration of the relation between the P_0 and P_1 components. The accuracy of the proposed method has been verified by comparing with exact calculation the diffusion length obtained by the present method in a uniform and infinite system: The diffusion length can be evaluated within 1% error. The present method has been further applied to one-dimensional fast reactor systems: The power distribution can be evaluated within 1%, and the neutron multiplication factor within 0.1%ΔK/K, in reference to S_{16} calculations. This accuracy is comparable to that of a response matrix method in which the Legendre expansion about the angle is performed with components taken up to P_1. The proposed method adopts the same number of unknown components of neutron current as in the current response matrix method (order P_0). The computing time is thus of comparable order between these two methods, which is much shorter than for the response matrix method using the P_1 angular distribution. The proposed method can hence be considered useful for one-dimensional transport problems, and should also have good prospects of proving equally effective for multi-dimensional problems.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 56281, 56735, 56871, 56872, 56873, 56977, 57332, 57812

56651 (CONF-770401—5) Where are we and where are we going in reactor shielding. Maienschein, F.C. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 11p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on reactor shielding; Knoxville, Tennessee, United States of America (USA) (18 Apr 1977).

Information on reactor shielding is presented concerning nuclear data in shielding calculations, analysis methods, water-cooled reactors, fast-breeder reactors, and fusion reactors.

56652 (MLM—2426(OP)) Isotopically tailored materials for fission and fusion reactors. DeWitt, R.; Wilkes, W.R.; Wittenberg, L.J. (Mound Lab., Miamisburg, Ohio (USA)). 1977. Contract EY-76-C-04-0053. 14p. (CONF-770566—1). Dep. NTIS, PC A02/MF A01.

From Ohio section meeting American Physical Society; Dayton, Ohio, United States of America (USA) (6 May 1977).

The use of isotopically enriched fuels in nuclear ractors is well known. In addition, because many structural components of a reactor are subjected to the neutron flux, the isotopic composition of these components can also affect the reactor performance. In many cases, the chemical compositions of these structural materials have been altered to either reduce their neutronic interactions or improve their radiation stability. Recently, several reactor specialists have suggested that the isotopic composition of some components could also be adjusted to improve their performance. The reactor characteristics that may be affected by such isotopic adjustments are: (1) neutron economy, (2) operating efficiency (life time and operating temperature), and (3) environmental impact (activation and transmutation products). Some examples of isotopic modifications which illustrate the benefits of isotopic tailoring of materials in fission reactors and in proposed fusion reactors are given.

56653 Microstructure, deformation, and fracture behavior of reactor core materials. Lee, D. (General Electric Co., Schenectady, NY). *Trans. Am. Nucl. Soc.;* **26**: 148(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56654 Simulation of void swelling: a critical review. Nelson, R.S. (Atomic Energy Research Establishment, Harwell, Eng.). *Trans. Am. Nucl. Soc.;* **26**: 178(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56655 Dry spent fuel cask handling system. Soeoet, O.; McPhee, A.H.; Harstead, G.A. (Soeoet and Harstead Association, P.C., New York). *Trans. Am. Nucl. Soc.;* **26**: 261(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56656 HI-CAP high-capacity fuel rack design. Jones, T.A.; Gauslow, R.W.; Bevilacqua, F. (Combustion Engineering, Inc., Windsor, CT). *Trans. Am. Nucl. Soc.;* **26**: 261-262(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56657 Advances in small zero-leak valves point to better nuclear power-plant reliability. Eacott, K.B. (Dresser Ind Inc). *Power (N.Y.);* **120**: No. 4, 60-62(Apr 1977).

Selection of nuclear valves in sizes of 2 in. and smaller needs serious consideration, because of demands for reliability and functional operability of nuclear components. Experience with modified conventional designs has borne fruit in steady improvements of bellows and metal-diaphragm methods for preventing outward leakage in the hundreds of 2-inch or smaller valves in a station. Several of the new designs have met the zero-leakage requirement, and, under lab conditions, most of the valves will probably meet the 4000-cycle life requirement of nuclear specifications.

56658 Surface flaw in a pressurised and thermally-shocked hollow cylinder. Kobayashi, A.S.; Emery, A.F.; Polvanich, N.; Love, W.J. (Univ of Wash, Seattle). *Int. J. Pressure Vessels Piping;* **5**: No. 2, 103-122(Apr 1977).

The first part of this paper deals with stress intensity factors of a semi-elliptical crack, with a third order polynomial pressure distribution in a finite thickness flat plate. These solutions are deter-

mined by the alternating technique in three-dimensional fracture mechanics where both the front and back surface effects of the flat plate are accounted for. The second part is concerned with the applications of these solutions in deriving approximate solutions for a semi-elliptical crack in a pressurized cylinder and in a thermally-shocked cylinder. 19 refs.

56659 Post-yield fracture mechanics theory and its application to pressure vessels. Chell, G.G. (Cent Electr Res Lab, Leatherhead, Surrey, Engl). *Int. J. Pressure Vessels Piping;* **5**: No. 2, 123-147(Apr 1977).

A post-yield fracture mechanics theory is presented based on Bilby, Cottrell and Swinden-Dugdale model solutions for cracks in bodies of finite width and subject to stress gradients. The model solutions are in good agreement with computed elastic-plastic values of the path independent integral J up to loads of 0.8 of the collapse load in the case of a cracked plate subject to bending. As an example, the model is applied to a thermal transient in a pressure vessel. The possibility of cracking and failure of a nozzle was considered. It was shown that a semicircular crack will grow into an extended defect. Therefore, in the main analyses, axial symmetry and infinitely long longitudinal and fully circumferential cracks were considered. The post-yield fracture mechanics solutions are presented in the form of elastic-plastic stress intensity factors. 22 refs.

56660 Steam-flow and seismic tests of nuclear ball valves verify design and fabrication. *Power (N.Y.);* **121**: No. 3, 60-62(Mar 1977).

A recent test of a Gulf and Western EPG Fluid Systems valve at Wyle Labs., in Huntsville, Ala., is described. The valve undergoing steam-flow and seismic tests was an 8-in. metal-seat ball valve, trunnion type, with an electrohydraulic actuator. It is concluded that a main steam isolation valve requires well-planned instrumentation and load application if full-scale tests are to develop maximum benefit. The high flow rates require some reduction in maximum valve size.

56661 Fracture in straight pipes under large deflection conditions. I. Structural deformations. Emery, A.F.; Love, W.J.; Kobayashi, A.S. (Univ of Wash, Seattle). *J. Pressure Vessel Technol.;* **99**: No. 1, 122-127(Feb 1977).

56662 Contributions of the ORNL piping program to nuclear piping design codes and standards. Moore, S.E. (Oak Ridge Natl Lab, Tenn). *J. Pressure Vessel Technol.;* **99**: No. 1, 224-230(Feb 1977).

This paper briefly reviews the history of piping-analysis standards; outlines the philosophy of the stress-index method of analysis; and explains some of the specific contributions made by the ORNL program to the Codes and Standards. Current and future work is also noted.

56663 Cooling tower feedwater treatment for nuclear power plants. Andres, O.; Flunkert, F.; Hampel, G.; Schiffers, A. (Rhein-Westfael Elektrizitaetswerkes, Essen). *Energie;* **29**: No. 1, 6-13(Jan 1977). (In German).

Various methods for make-up of feedwater to cooling towers are evaluated. A discussion is made on possible waste heat utilization, rather than dispose vapors into the surrounding atmosphere. 11 refs.

56664 Using sliding live steam pressure to control the capacity of power units of nuclear power plants. Arkad'ev, B.A.; Palei, V.A.; Ioffe, V.Yu.; Shor, V.L.; Kelin, G.E. (Minenergo, SSR). *Teploenergetika (Moscow);* No. 1, 39-42(Jan 1977). (In Russian).

Some ways to improve the efficiency of operation of large steam turbines with throttle steam distribution under partial loads are considered. Relying on calculations of variable regimes of nuclear power plant turbosets, the expediency of utilization of sliding pressure of live steam, in particular for plants with steam-steam intermediate superheating, is demonstrted.

56665 Measurement of Nb 93m activity determining the fluence of fast neutrons in power reactors. Wille, P. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik). *Atomkernenergie;* **29**: No. 2, 166-168(1977). (In German).

From Technical meeting on radiation exposure and damage of reactor components outside the reactor core; Stuttgart, Germany, F.R. (23 Sep 1976).

2 figs.; 5 refs.

In recent years niobium instead of nickel or iron is increasingly used in nuclear reactors to determine the fluence of fast neutrons. The reasons are the low energy threshold for inelastic neutron scattering and the long half-life compared to Co 58 or Mn 54 which have normally been used in the past. Small amounts of tantalum (approximately 100 ppm wt) which are always present in niobium cause interference of the Nb 93m activity if one chooses the usual measurement of the X-rays emitted. The problem of the interfering activity was solved by two methods. The first method utilizes the separation of tantalum by paper chromatography. From a solution of HF + HNO_3 which dissolved niobium, an amount of about 0.5 mg Nb/10 µl solution is pipetted on pc-paper run with a mixture of HF, HNO_3, butanol and water. The activity should not be much less than 1 µCi Nb93m. The purified niobium then can be measured with a lithium-drifted silicon-detector. The second method makes use of the decrease of the tantalum interference of the Nb93m activity Asub(Nb) by the shorter half-life of Ta 182. The use of niobium as fast neutron fluence monitor should offer no problems, if sufficient knowledge exists concerning the half-life, the K-conversion ratio, the Auger ratio and the differential cross section of niobium. However, these data are not yet sufficiently well known. Therefore, efforts to improve them are urgently required.

56666 Technical re-equipment of nuclear power engineering and boiler engineering plants. Parshutina, R.A.; Vagizova, I.P. *Energomashinostroenie;* No. 1, 3, 26(1977). (In Russian).

Some salient points from the Soviet plans for the re-equipment of nuclear power engineering and boiler engineering plants in the USSR in the 1976-1980 period are considered.

56667 Pressure vessel technology. I. Analysis, design, and inspection. New York; American Society of Mechanical Engineers (1977). 514p. (CONF-770414—P1). .

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

Included are fifty papers, eighteen of which have been separately processed for the Energy Data Base. (DG)

56668 Application of a general purpose finite element program system in pressure vessel technology. Aamodt, B.; Sandsmark, N.; Medonos, S. (Det Norske Veritas, Hovik, Norway). pp 329-340 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

Main advantages of using general purpose finite element program systems in structural analysis are summarized. Several illustrative applications of the program system SESAM-69 to pressure vessel problems are described. The first example is a dynamic analysis of the motor housing of the internal main circulation pump of a BWR nuclear reactor. The next example is a transient heat conduction and stress analysis of deflector of feeding nozzle of PWR nuclear reactor. Then, numerical calculations of stress intensity factors and fatigue crack growth of semi-elliptical surface cracks are discussed. And finally, an elasto-plastic analysis of a thick plate with edge-cracks is considered. It is concluded that due to the fact that general purpose finite element program systems are general and user-orientated, they will gain increasingly higher popularity in the years ahead.

56669 Basic formulation and a computer program for inelastic large deformation analysis. Yamada, Y. (Tokyo Univ.); Sakurai, T. pp 341-352 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

Basic formulation for a computer program COMPOSITE-III and some typical numerical examples are presented. The program was originally developed for simulating the mechanical behavior of composite materials and has been extended to be operational as a general purpose program for the thermal-elastic-plastic-creep analysis of nuclear reactor and high temperature heat exchanger components. The formulation is of the updated Eulerian type and features the adoption of a mechanical model, specifically the generalized Voigt (or Kelvin) model, in the description of time-dependent creep behavior. The constitutive equation relevant to the model is first derived, which forms the basis of our method of solution for inelastic but infinitesimal deformation. The second part of the paper deals with the large deformation and discusses in detail the geometric stiffness and load correction matrices, and solution procedure which incorporates the search for critical load points as well as eigenmodes.

56670 Systems approach to structural reliability assurance. Chang, E.C.; Garrity, W.E. (General Electric Co., Sunnyvale, CA). pp 465-474 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

A strong structural reliability program is the result of a dynamic approach that encompasses adequate reliability assurance activities in conjunction with sound basic engineering procedures. Basic engineering procedures are those pursuits that make up the engineering design process for an item or system, including design, fabrication, erection, testing, and operation. Reliability assurance is broadly defined as the systematic activities which seek to confirm

that an item possesses the design characteristics necessary to provide adequate reliability in service. Whereas the basic engineering procedures form the classical mainstream of system production, the reliability assurance function provides an important input that attempts to assure the reliability of the end product.

56671 Pressure vessel technology. II. Materials and fabrication. New York; American Society of Mechanical Engineers (1977). 519p. (CONF-770414—P2). .

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

Included are fifty-three papers, twenty-six of which have been separately processed for the Energy Data Base. (DG)

56672 Corner crack at a nozzle. Kobayashi, A.S.; Polvanich, N.; Emery, A.F.; Love, W.J. (Univ. of Washington, Seattle). pp 507-515 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

A procedure for estimating the stress intensity factor of a corner crack at a nozzle-to-cylinder junction using stress intensity factors of quarter-elliptical cracks in a quarter-infinite solid and those of fully embedded or partially penetrated circular cracks in a three-quarter infinite solid is discussed. The proposed procedure is used to analyze hypothetical quarter circular cracks at a nozzle-to-cylinder junction where the stress distribution in the uncracked junction is known.

56673 Model for fracture mechanical estimation of the failure probability of reactor pressure vessels. Nilsson, F. (Royal Inst. of Tech., Stockholm). pp 593-601 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

A model for the estimation of the failure probability of a reactor pressure vessel is described. It is based on probabilistic fracture mechanics. The model permits random character of several design quantities such as material properties, loading, defect distribution and detection capability. A particular set of input data is discussed and used as an example.

56674 Fracture toughness of welded joints of ASTM A543 steel plate. Susukida, H. (Takasago Technical Inst., Japan); Uebayashi, T.; Yoshida, K.; Ando, Y. pp 619-625 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

Fracture toughness and weldability tests have been performed on a high strength steel which is a modification of ASTM A543 Grade B Class 1 steel, with a view to using it for nuclear reactor containment vessels. The results showed that fracture toughness of welded joints of ASTM A543 modified high strength steel is superior and the steel is suitable for manufacturing the containment vessels.

56675 Failure assessment of pressure vessels under yielding conditions. Harrison, R.P.; Darlaston, B.J.L.; Townley, C.H.A. (Central Electricity Generating Board, Berkeley, Eng.). pp 661-668 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

The paper summarizes the work carried out to establish the behavior of structures containing defects and outlines a failure assessment route which can be used to assess the integrity of a structure containing a defect. The basis for this failure assessment route is the two-criteria approach of Dowling and Townley, which can be applied to structures containing defects irrespective of whether they are in the linear elastic fracture mechanics regime, the fully plastic regime, or in an intermediate regime. The extension of this concept to include crack growth by stable tearing is dealt with in the paper.

56676 Cyclic stress strain behavior of four nuclear pressure vessel materials. Kitagawa, M.; Tamura, K.; Fukagawa, M.; Saiga, Y. (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo). pp 765-771 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

The constitutive equation under cyclic loading is needed for an inelastic analysis of nuclear components when the design requirement based on an elastic analysis is not satisfied. In order to characterize the cyclic stress strain behavior, a series of low cycle fatigue tests, each of which has a different strain sequence, are performed on four pressure vessel materials, namely A508 Cl. 2 steel, A533 Gr. B steel, SUS304 stainless steel and Inconel 600 alloy. It was found that the strain history dependence of cyclic stress-strain behavior of these materials is governed mainly by the cyclic softening and strain softening (strain hardening for SUS304 stainless steel). The phenomena of cyclic softening and strain softening can be evaluated by a simple model. SUS304 stainless steel and Inconel 600 alloy also show a period of cyclic hardening which is added to the cyclic softening and strain softening. The hysteresis loop of these materials can be approximated by cyclic stress strain curves obtained by the incremental step test.

56677 Statistical methods for interpreting fatigue crack growth data with applications to reactor pressure vessel steels. Bamford, W.H. (Westinghouse Nuclear Energy Systems, Pittsburgh); Shaffer, D.H.; Jouris, G.M. pp 815-823 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

The purpose of the paper is to propose methods which are statistically sound to provide a consistent interpretation of crack growth data. Such a method has the advantage of providing a basis for probabilistic studies of ractor vessel integrity. The procedure begins with crack length versus cycle data for tests of precracked specimens of any type or material. Methods are presented to reduce and analyze these data to produce a global confidence limit on the crack growth rate as a function of stress intensity factor range. Next, methods are discussed which produce an estimate of the tolerance limits for the crack growth rates as a function of stress intensity factor range. These limits refer to the region in which a large proportion of the crack growth rate data fall.

56678 Manufacture of heavy reactor components with particular consideration to quality assurance. Clausmeyer, H.; Kreppel, H. (Gutehoffnunghuette Sterkrade AG, Oberhausen, Ger.). pp 915-923 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

The use of adequate quality assurance measures is one of the most important prerequisites for the manufacture of reactor components. Nature and extent of the quality assurance system at present adopted in the Federal Republic of Germany are illustrated, using the manufacture of a reactor pressure vessel as an example. The system comprises quality organization, planning of all quality assurance measures, quality surveillance through all stages of manufacture and documentation of quality attained.

56679 Explosive plugging of nuclear heat exchangers. Crossland, B.; Bahrani, A.S.; Townsley, W.J. (Queen's Univ., Belfast). pp 971-983 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

Explosive welding is a well established process for cladding one metal on another or for welding tubes to tubeplates or lap welding, etc. Recently, the process has been adapted to plugging of heat exchangers in conventional and nuclear power plant, where it has already been accepted especially in situations where the access is difficult and remote from the site of plugging. The paper describes the explosive plugging techniques developed in the Department of Mechanical and Industrial Engineering of The Queen's University of Belfast for the reheater and superheater of the PFR, and for the reheater of the AGR. For the PFR a point charge system has been used which causes a spherical expansion of the plug, which gives two zones of welding. Initially for the much larger plug required for the AGR it was proposed to use a parallel stand-off welding set-up, but it proved difficult or impossible to avoid a crevice. Consequently, a rim charge set-up has been developed which gives a circular ring expansion of the plug with two zones of welding. Besides the problem of the design of the plug and explosive charge geometry it has also been necessary to consider the distortion of holes adjoining the hole in which a plug is welded. Bunging of adjoining holes in order to reduce the distortion has also been investigated.

56680 Properties of explosive-welded Monel-clad steels. Kihara, H.; Inagaki, M.; Nakamura, Y.; Kuriyama, R.; Takizawa, I.; Sugiyama, S.; Ikkai, T.; Tamai, Y.; Naito, Y.; Onuki, Y. pp 985-992 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

Explosive-welded Monel clad steel was used as clad material for a high-pressure nuclear heat exchanger. The properties of explo-

sive-welded Monel clad steel are reported briefly. Rolled or forged carbon steel pieces on which 4- or 12-mm thick Monel plate was explosive-welded were welded together. The welded pieces were subject to stress-relief heat-treatment, cold or hot roll to examine in detail the mechanical properties such as peeling of the explosive-welded portions.

56681 Development and tests of a condenser/degasser designed by VTI for special water purification systems of nuclear power plants. Pis'man, B.Ya.; Khlyustova, T.M.; Komkova, G.I.; Stolyarov, G.M.; Matskevich, G.V.; Chernyi, S.S. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 12, 69-72(Dec 1976). (In Russian).

A description is presented of a condenser/degasser designed by the All-Union Thermal Engineering Institute for special water purification systems of nuclear power plants. Likewise, results of tests of the condenser/degasser under industrial conditions are presented.

56682 Usefulness and methods of periodic treatment of extrareactor part of single-loop nuclear power plants. Margulova, T.Kh.; Shchapov, G.A.; Shirokov, S.V.; Kireev, G.A.; Boguslavskii, V.B.; Al'tshuller, M.A. (Moscow Energet Inst, USSR). *Teploenergetika (Moscow);* No. 12, 81-82(Dec 1976). (In Russian).

It is argued that nuclear power plant projects must envisage simple and reliable elements facilitating periodic chemical treatment and deactivation of the main parts of the regenerative system of single-loops of nuclear power plants. These elements should also be used for periodic treatment of the given equipment to improve general resistance of steel to corrosion and erosion before putting the plants out of service for overhaul or before putting them again into service. A diagram of an installation built for this purpose at the Beloyarskaya nuclear power plant and explanation of its operation is given.

56683 Feed pump drives - a cost comparison between steam turbine and electric-driven propulsion. Steffan, W. (Brown, Boveri und Cie A.G., Mannheim (Germany, F.R.)). *VGB Kraftwerkstech.;* **56**: No. 10, 605-610(Nov 1976). (In German).

10 figs.; 3 tabs.; with refs.

The high proportion of station service power, the increasing plant capacity and thus the increasing pump capacities, more sophisticated drive components, alterations in the mode of operation, in the operating costs, and in the load programmes make it necessary that feed pump drives and their economy are gone into again. For three power plant types often under discussion at the moment, the feed pump drives have been investigated: 1) fossil-fuel power stations with a unit capacity of MW 600; 2) nuclear power plant with PWR with a unit capacity of MW 1,200; 3) nuclear power plant with HTR with a unit capacity of MW 1,200.

56684 Effect of the frequency of rotation on the efficiency of a centrifugal pump with a low n/sub s/. Aleksapol'skii, D.Ya.; Malyushenko, V.V.; Rzhebaeva, N.K. (Khar'kov Polytech Inst im. V.I. Lenin, Sumy, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* 105-109(Nov 1976). (In Russian).

Results of an experimental investigation of the effect of the frequency of rotation on the efficiency of centrifugal pumps with a low pumping rate n$sub s$ (40-50) are presented. A relation is obtained for the determination of efficiency correction factor when the frequency of rotationg of such pumps changes.

56685 Pressure containing welds in nuclear power systems : meeting the special requirements. Singal, R.K.; Garg, I.D. *Electr. India;* **16**: No. 18, 5-15(30 Sep 1976).

Welded components, whose failure could have severe consequences on the safety and reliability of nuclear power plants, are of great importance, and a quality assurance programme is required by law for each of these plants. Special requirements such as nil-ductility transition temperature, corrosion stresses due to high operating temperature and pressure, etc. are outlined. A detailed description of the quality assurance program is given. Specific requirements of the pressure containing welds have been discussed. Special steps taken during design, fabrication, inspection and testing, operation of the plant and in-service inspection which have been brought out to meet the above demands are explained. The information is based on the research and development work being carried out in different countries and manufacturing practice being followed for the fabrication of nuclear components in India and abroad. Specific examples are cited from the experience gained in the development of indigenous capability for fabrication of critical reactor equipment and components for the Rajasthan Atomic Power Project such as the calandria, end shields, end shield ring assemblies, steam generators, moderator heat exchangers and tanks, dump tank, nuclear piping, etc.

56686 Experience of industrial operation of wash-in cartridge filters in chemical water purification schemes of nuclear power plants. Nudel', A.M.; Gerasimov, V.S.; Zolotukhin, S.T.; Baronkin, Yu.F.; Rogov, K.D.; Neshkov, P.F. *Teploenergetika (Moscow);* No. 9, 12-14(Sep 1976). (In Russian).

Results of operation of wash-in cartridge filters in the water-purification schemes of the first loop, of loosening-up waters, and of oil-contaminated condensate are set forth. Characteristics of the auxiliary filtering material, the conditions of washing-in of the auxiliary layer, filtration and chemical regeneration of cartridges are given.

56687 Investigation of magnetic filters for iron removal from feedwater of steam generators at nuclear power plants. Shterenshis, I.P.; Lazarev, I.P.; Fartukov, S.V. *Teploenergetika (Moscow);* No. 9, 18-20(Sep 1976). (In Russian).

Results of production tests of a magnetic and an electromagnetic filter for purification of turbine condensate and feedwater of nuclear power plant steam generators from ferromagnetic iron oxides are presented.

56688 Effect of pressure loss components on dynamic stability of water-steam mixture flow in once through steam generator channel. Polak, V. (Vyskumny Ustav Energeticky, Jaslovske Bohunice (Czechoslovakia)). *Jad. Energ.;* **22**: No. 8, 293-296(Aug 1976). (In Slovak).

Water-steam mixture flow dynamic stability in the channel of the once-through steam generator is studied by solving a characteristic equation of the closed circuit of a multiple feedback system. An analysis is made of the individual components of pressure losses with regard to their stabilization or destabilization effect on flow changes in the concrete given system.

56689 Application of conversational procedure to optimization of multi-layer radiation shielding design. Uchikawa, T.; Kobayashi, Y.; Kondo, S.; Togo, Y. (Tokyo Univ. (Japan). Faculty of Engineering). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 8, 423-431(Aug 1976).

A conversational procedure for the design of multi-layer shields has been developed and applied to parametric survey and weight minimization studies. The performance of various shielding designs is evaluated with the matrix method, after which the matrices are calculated by Sn technique. Numerical examples of water and iron laminated slab shields reveal not only the effects resulting from the combination of different shielding materials but also the usefulness of the interactive procedure for solving design problems. In another sample problem of weight minimization, an improvement of 1% has been obtained after a score of trials, despite the fact that the initial design had been carefully optimized by parametric study.

56690 Efficient finite element method for nonlinear structural mechanics and its application to transient creep analysis. Yagawa, G.; Miyazaki, N. (Tokyo Univ. (Japan). Faculty of Engineering). *Nippon Kikai Gakkai Rombunshu;* **42**: No. 359, 2007-2014(Jul 1976). (In Japanese).

The superposition of analytic solution and finite element solution and the variational principle were applied to elasto-plastic problems and crack problems. The reasonable solutions were obtained. The nonlinear structural analysis method by the superposition was generalized and was applied to unsteady creep analysis.

56691 Stress analysis of partial sphere used for bottom shell of off-shore structure. Nishimaki, K.; Matsumoto, K.; Hori, T.; Takeshita, H.; Iwata, S. (Hitachi Shipbuilding and Engineering Co. Ltd., Osaka (Japan). Technical Research Lab.). *Hitachi Zosen Giho;* **37**: No. 2, 61-68(Jun 1976). (In Japanese).

In the near future, various huge off-shore structures will be constructed. Concrete shall become a leading material in the structures, owing to its versatile properties. One of the limitations of concrete is its low tensile strength. The problem of low tensile strength of concrete is dealt with in main by two different methods: by applying prestressing and by designing the structural configuration so that no tensile stresses appear. The authors discuss the application of partially spherical shell to huge off-shore structures. Structural analysis by using the finite element method were done in order to investigate the feasibility of the structure. The results were arranged as to certain parameters to derive design charts by which the stresses of check points can be presumed. Optimum shape is also discussed.

56692 Fatigue damage on large components. Hagn, L.; Effertz, P.H.; Schueller, H.J. pp 157-170 of In Werkstoff- und Bauteilverhalten unter Schwingbeanspruchung. Duesseldorf, Germany, F.R.; VDI (1976). (In German)

From Meeting on the behavior of materials and components under vibrational stress; Stuttgart, Germany, F.R. (11 Nov 1976).

35 figs.; 15 refs.

The five reported cases of damage are to be attributed, like all fatigue fractures, to growing or cyclic overstressing. Overstressing means that within clearly bounded regions the fatigue strength for finite life or the fatigue limit of stress of the material is exceeded and therefore the desired design strength of the component was not reached, if extraordinary sudden overloads by maloperation and

penetrated foreign bodies or as a consequence of a previous damage remain unaccounted for.

56693 Rectifier motor as a drive for axial pumps. Saupe, R. (Allgemeine Elektricitaets-Gesellschaft AEG Telefunken, Berlin (Germany, F.R.). Stromrichterfabrik). pp 85-89 of In 2. Mitgliederversammlung und Fachtagung der VDI/VDE-Gesellschaft Mess- und Regelungstechnik (GMR). Duesseldorf, Germany, F.R.; VDI (1976). (In German)

From 2. meeting of the members and specialists' meeting of the VDI/VDE-Gesellschaft Mess- und Regelungstechnik (GMR); Wiesbaden, Germany, F.R. (18 - 19 Nov 1976).

9 figs.

In nuclear power plants a maximum availability is expected from the drives of axial pumps, the internal forced circulation pumps, since the power of the nuclear plant is controlled using them. The drive system rectifier motor fulfills these conditions since it has the good regulation properties of a direct current engine as well as the service-freeness and the robustness of a three-phase engine.

56694 Prospects of improving pearlitic steels for reactor shells and other equipment of the first loop of nuclear power plants. Balandin, Yu.F.; Gorynin, I.V.; Zvezdin, Yu.I.; Maslenok, B.A.; Nikolaev, V.A.; Sobolev, Yu.V. *Energomashinostroenie;* No. 10, 25-28(1976). (In Russian).

The ways to create new steel grades for reactor shells of nuclear power plants are considered. The joint effect of chromium and nickel on the properties of low-carbon complex-alloyed steels is studied. New principles of alloying pearlitic steels are formulated. Various Cr-Ni-Mo steel compositions are discussed.

56695 Manufacture of multi-layered casings of stationary apparatus and problems of their strength. Postoev, V.S.; Ryndin, N.I. *Energomashinostroenie;* No. 10, 28-29(1976). (In Russian).

The advantages of multi-layered vessels compared with the unit-forged, forged-and-welded, and stamped-and-welded ones are pointed out. Problems of strength in conditions of static and sign-variable loading are formulated. 9 refs.

56696 State of the art and trends in the development of foreign turbine construction for nuclear power plants. Smirnov, V.I.; Krug, V.V. *Energomashinostroenie;* No. 11, 21-23(1976). (In Russian).

A review of steam turbine construction in the capitalist countries, especially in the US, Western Europe, Japan, with reference to the nuclear power plant development programs for the next 10-20 years is presented. The role of turbines for nuclear power plants in the total volume of steam turbine construction in the capitalist countries is considered. Data about the expansion and modernization of research and manufacturing in this field are presented and principal technical characteristics of large steam turbines for nuclear power plants are given.

56697 Apparatus for controlling vapor temperature in a nuclear power plant. Mega, T. (to Mitsubishi Heavy Industries, Ltd., Tokyo (Japan)). Japanese Patent 1976-104,192/A/. 12 Mar 1975. 4p. (In Japanese).

Object: To enable to maintain temperature of vapor from a heater and a reheater in a given allowable range to effect immediate and stable following control in response to variation in load. Structure: Vapor temperature from a superheater entering a high pressure turbine and vapor temperature from a reheater entering a low pressure turbine are detected by a first and a second detectors, respectively, these temperatures being compared and operated with a reference value separately determined to feed a control signal in proportion to flow rate of heating medium to a flow control valve and a double flow valve, thereby controlling the flow rate of the heating medium.

56698 Apparatus for measuring neutron flux distribution in a reactor. Kiguchi, T.; Motoda, H.; Kawai, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-104,196/A/. 10 Mar 1975. 3p. (In Japanese).

Object: To display a neutron flux by an output signal of a neutron distribution movable measuring element in a reactor while removing a shaking portion thereof by operation. Structure: A plurality of fixed neutron detectors and movable detectors are provided within a core. The fixed detectors provide a mean neutron signal P(t) of the core, and a time mean P^* is calculated by an operator from the signal P(t). Let P(r) be the signal at position r of the movable detector, then, the value with a shaking portion of the neutron removed is obtained by a specific equation with P(r), P(t) and P^* being variable, the value being processed by the operator for display.

56699 Square through tube. Akita, J.; Honma, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-99,795/A/. 28 Feb 1975. 3p. (In Japanese).

Object: To provide a square through tube involving thermal movement in pipelines such as water supply pump driving turbine exhaust pipe (square-shaped), which is wide in freedom with respect to shape and dimension thereof for efficient installation at site. Structure: In a through tube to be airtightly retained for purpose of decontamination in an atomic power plant, comprising a seal rubber plate, a band and a bolt and a nut for securing said plate, the seal rubber plate being worked into the desired shape so that it may be placed in intimate contact with the concrete floor surface by utilization of elasticity of rubber, thereby providing airtightness at a corner portion of the square tube.

56700 Shielding construction for a reactor. Tanaka, Y. (to Kawasaki Heavy Industries Ltd., Kobe (Japan)). Japanese Patent 1976-98,494/A/. 25 Feb 1975. 4p. (In Japanese).

Object: To restrain the activated amount of a reactor vessel to a level less than an accessible dose at the time of inspection during use and at the same time to decrease the activated amount of conventional concrete as a biological shield layer to a level less than an allowable dose, which amount is out of question at the time of disassembly. Structure: Between a reactor vessel and a biological shield layer in the form of a conventional concrete is disposed an intermediate shield layer, which can be disassembled and removed, made of elements such as Fe, Co, Sc, Eu, etc. and a shield material limiting content of water and containing a thermal neutron sink, to enable access inspection without requiring particular shield during use.

56701 Method for the arrangement of activated carbon adsorption tower. Saito, T.; Takejima, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-97,000/A/. 24 Feb 1975. 3p. (In Japanese).

Object: To decrease a dose rate in the surface of a shielding wall of a rare gas holdup device to reduce the thickness of the shielding wall. Structure: The shielding wall is internally provided with adsorption towers which adsorb rare gases from waste gases in a reactor. At this time, an adsorption tower which is susceptible to the highest radioactivity is arranged centrally and other towers are arranged externally of the centrally arranged tower in order of level in radioactivity from higher to lower and in triangular pitch relation in longitudinal and lateral directions. Thereby, the adsorption tower which is susceptible to the higher radioactivity is greatly held away from the shielding wall to decrease the dose rate relative to the shielding wall.

56702 Leakage control device in a main steam isolating valve. Yoshimoto, Y.; Ochiai, K.; Miyakawa, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-96,994/A/. 21 Feb 1975. 4p. (In Japanese).

Object: To return all of leaked steam into a reactor receiving container despite the state of trouble to minimize the discharge of radioactive material at the time of trouble. Structure: A leakage control system for main steam isolating valves communicating the main steam isolating valves disposed in a main steam pipeline with a pressure control chamber, the system including a condenser and an ejector, the condenser being communicated with the ejector through a pump, the condenser causing the isolating valves to be negative pressure, non-condensed gases contained in condensation and leaked steam being fed to the pressure control chamber through the pump and ejector.

56703 Leakage detecting apparatus in an atomic power plant. Koba, A.; Goto, S. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-95,597/A/. 19 Feb 1975. 3p. (In Japanese).

Object: To quickly detect even a fine amount of leakage of high temperature and high pressure steam or the like. Structure: A normal condition of piping for high temperature and high pressure steam in an atomic power plant is stored as a picture signal in a picture memory and infrared rays produced in heat generated state resulting from leakage of the high temperature and high pressure steam are taken by an infrared ray television camera to produce a picture signal, the picture signal in the normal condition is compared with the picture signal produced by the infrared ray television camera to produce an alarm from an alarm generator.

56704 Device for increasing fluid resistance in a core vessel cooling system. Shiraishi, T. (to Mitsubishi Heavy Industries, Ltd., Tokyo (Japan)). Japanese Patent 1976-87,698/A/. 30 Jan 1975. 3p. (In Japanese).

Object: To pierce a small hole in a side surface of a reactor cooler so that when pressure within the reactor is increased to back-flow a cooling liquid in a cooling pipe, fluid resistance within the pipe is increased to reduce a back-flow speed of the cooling liquid. Structure: A cooling pipe extending through walls of a reactor is formed with a small hole to be disposed at a part thereof within the reactor. In normal operation, the cooling liquid is passed in a given direction to cause the cooling liquid to be poured into the reactor. When pressure within the reactor is abnormally increased and the cooling liquid tends to be flown back in the opposite direction from the interior of the reactor, the cooling liquid within the reactor flows into the cooling pipe through the small hole. As a consequence, the

fluid resistance within the pipe increases so that outflow of cooling liquid from the core may be delayed.

56705 Water supply system. Matsumura, J.; Kusayama, Y. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-84,401/A/. 22 Jan 1975. 3p. (In Japanese).

Object: To prevent pump trip in an atomic power plant water supply system by so arranging as to supply replenishment water from surge tanks. Structure: Condensing pumps, condensed water pressure step-up pumps and water supply pumps are provided in the mentioned order between condenser and nuclear reactor and surge tanks are provided on the downstream side of the pumps. When the pump upstream side is tripped, this is compensated for by replenishment water which is supplied from the downstream side surge tank.

56706 First-rate prestressed concrete structures in underground workings: oceanic buildings, nuclear power plants, containers and tunnels. Arnold, G. *Beton Stahlbetonbau;* 70: No. 2, 38-44(1975). (In German).

24 figs.; 9 refs.

Apart from construction examples with prestressed concrete, its use in reactor containments is also described.

FUEL ELEMENTS

REFER ALSO TO CITATION(S) 55962

56707 Efect of porosity on the steady-state swelling of UC. Villolobas, A.; Wazzan, A.R.; Okrent, D. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* 26: 170-171(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56708 Effects of fill-gas composition and eccentric gap geometry on gap conductance of UO_2 fuel rods. Williford, R.E.; Hann, C.R. (Battelle Pacific Northwest Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* 26: 324-325(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56709 Equilibrium index for fission gas bubbles. Wang, W.L.; Singh, R.N. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* 26: 377-378(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56710 Development of plutonium fuels in PNC. Akutsu, H.; Muto, T. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). *Nippon Genshiryoku Gakkaishi;* 18: No. 7, 423-432(Jul 1976). (In Japanese).

The result and experience on Pu fuels and their handling in Power Reactor and Nuclear Fuel Development Corp. are compiled in memory of the 10th anniversary of establishment of the first Pu fuel laboratory on Nov. 26, 1960. The second facility was built at the end of 1971 as a Pu fuel frabrication facility. The amount of Pu fuels fabricated in both facilities reached 15,000 fuel rods with 13t of mixed oxide pellets mostly for JOYO and DCA, and is further increasing for FUGEN. Quality assurance system has been arranged in accordance with increase of the fuel produced, and a fully documented system was completed for the FUGEN Pu fuel. Research and development work for Pu fuels has been focussed on physical properties of mixed oxide, and in and out of pile evaluation of the fuel performance together with some activities related to Pu fuel design, and these results have been compiled in computer codes including fuel performance codes, PIPER and ACTIVE-II. Irradiation testings of the mixed oxide fuels totaling 418 rods were carried out successfully in JRR-2, JMTR, HBWR, SAXTON, GETR, Rapsodie and Dounreay. Besides, 3,624 fuel rods were fabricated and used for critical experiments in DCA, TCA, etc. Concerning the safety control against Pu handling were described control systems for confinement, criticality, accountancy, radiation exposure, and safeguarding, stressed on so-called "zero contamination control".

56711 Industrial technique. (to Babcock and Wilcox Co., New York (USA)). Netherlands Patent 7,604,115/A/. 20 Apr 1976. 11p. (In Dutch).

Priority 1 Aug 1975, US; 6 figs.

A typical embodiment of this invention has an end fitting for a nuclear reactor fuel element that is joined to the control rod guide tubes by means of a nut plate assembly. The nut plate assembly has an array of nuts, each engaging the respective threaded end of the control rod guide tubes. The nuts, moreover, are retained on the plate during handling and before fuel element assembly by means of hollow cylindrical locking cups that are brazed to the plate and loosely circumscribe the individual enclosed nuts. After the nuts are threaded onto the respective guide tube ends, the locking cups are partially deformed to prevent one or more of the nuts from working loose during reactor operation. The locking cups also prevent loose or broken end fitting parts from becoming entrained in the reactor coolant.

56712 Device for continuous electrolytic polishing of rod-shaped work pieces of zirconium alloys. Koehler, L. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 1,931,174/C/. 15 Apr 1976. 3p. (In German).

2 figs.

In order to give rod-shaped work materials of zirconium alloys, used in nuclear reactor plants, an extremely corrosion-resistant surface, it is best to electropolish them. In order to improve the method for continuous electropolishing, the electrolyte container surrounding the work piece and simultaneously acting as cathode has elastic seals on both sides which act as a barrier to the electrodes, as well as guarantee the exact centering of the work pieces passing through. The seals are cast of silicon caoutchouc and are designed to have a high-pressure gas padding. Furthermore, advantageous layouts of the apparatus (cooling, introduction, inner walling, material) are described.

56713 Apparatus for mixing particulate substances using a fluid under pressure. Davis, D.E.; Foster, S.J. (to General Atomic Co., San Diego, Calif. (USA)). French Patent 2,293,973/A/. 11 Dec 1975. 10p. (In French).

Priority claim: 13 Dec 1974, US.

The mixing apparatus described for mixing particulates includes a mixing chamber, an enclosure around this mixing chamber near its lower end, an annular slot to allow communication between the enclosure and the mixing chamber, and a system for bringing the pressurized fluid towards the enclosure so that it flows through the slot to stir the particulate substances contained in the mixing chamber. It can be used in the fabrication of certain kinds of nuclear fuel rods.

56714 Method and fluidized bed furnace for coating nuclear fuel particles and others. Lefevre, R.L.R.; Price, M.S.T. (to Commission of the European Communities, Luxembourg). French Patent 2,280,425/A/. 29 Jul 1975. 13p. (In French).

Priority claim: 2 Aug 1974, UK.

A coating process is described, involving the injection of a coating gas into the bottom of a fluidized bed furnace and the injection of an inert gas into the same region to surround the coating gas. The relative flow-rates of the gases are adjusted to prevent their mixture and to establish inside the furnace an inner zone rich in coating gas where the coating is deposited on the articles. This inner zone is surrounded by an outer zone rich in inert gas. The articles treated are nuclear fuel particles (uranium, plutonium or thorium).

56715 Fuel assembly in a reactor. Saito, S.; Kawahara, A. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-101,688/A/. 5 Mar 1975. 7p. (In Japanese).

Object: To provide a fuel assembly in a reactor which can effectively prevent damage of the clad tube caused by mutual interference between pellets and the clad tube. Structure: A clad tube for a fuel element, which is located in the outer peripheral portion, among the fuel elements constituting fuel assemblies arranged in assembled and lattice fashion within a channel box, is increased in thickness by reducing the inside diameter thereof to be smaller than that of fuel elements internally located, thereby preventing damage of the clad tube resulting from rapid rise in output produced when control rods are removed.

56716 Fuel assembly. Ikeda, M.; Kamo, Y. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-9,493/A/. 26 Feb 1975. 5p. (In Japanese).

Object: To axially divide a fuel assembly into a plurality in number for use while replaced to render effective burning of fuel possible. Structure: The fuel assembly comprises a plurality of axially and equally divided fuel blocks, engaging means provided with a projection arranged between the fuel blocks and held by means of an elastometric body in order to engage upper and lower fuel blocks, and recessed portions formed at upper and lower ends of the fuel blocks to receive therein the projection of the engaging means.

56717 Fuel assembly in a reactor. Hosokawa, T.; Maki, H.; Shinpo, K.; Ando, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-96,991/A/. 21 Feb 1975. 6p. (In Japanese).

Object: To provide a fuel assembly in a reactor including fuel rods made of a furnable poisonous material, which is low in probability of damage and safety. Structure: The assembly comprises a plurality of reactor fuel rods, which form a first group, with a furnable poisonous material added thereto, and a second group of reactor fuel rods with the furnable poisonous meterial not added thereto, the first group providing a greater ratio of gap between clad

tubes for the fuel rods to the diameter of a fuel rod body than the other group.

56718 Nuclear fuel pellets. Hosokawa, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-96,996/A/. 21 Feb 1975. 5p. (In Japanese).

Object: To decrease deformation of clad tubes resulted from thermal deformation of sintered pellets such as uranium dioxide fuel charged into the clad tubes. Structure: The device comprises a clad tube, into which a plurality of cylindrical pellets, a spring for biasing and absorbing expansion of the pellets in the lengthwise direction, and upper and lower plugs for sealing the clad tube. The cylindrical fuel pellets have their outer peripheral portions of upper and lower ends thereof chamfered through the length more than 0.3 time of the pellet diameter in the lengthwise direction of the pellets and through the length more than 0.0035 time of the pellet diameter in the radial direction thereof.

56719 Nuclear fuel element. Saito, K.; Oguma, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-96,997/A/. 21 Feb 1975. 4p. (In Japanese).

Object: To decrease troubles in breakage of fuel by preventing movement of fuel pellets prior to charging load into reactor and by enabling the fuel pellets to be extended axially after charging of load into the reactor. Structure: The clad tube is interiorly filled with a plurality of pellets, upper and lower ends of which are sealed by end plugs. A sealing container is provided at the portion located at the upper part of the fuel element. This sealing container is of the bellows type, at the upper part of which is formed with an opening, which is filled with low melting point metal after gases have been sealed into the sealing container. Prior to charging load into the reactor, the bellows type sealing container is urged to bear on the fuel pellets under the force of pressure gases to restrain movement of the pellets, whereas when the reactor is charged with load and then used at an operating temperature, the low melting point metal is dissolved to open the opening, and as a consequence the sealing container is shrunk to lose its spring effect, thus allowing the fuel pellets to be expanded axially.

56720 Fuel rod in a reactor. Maki, K.; Ito, S.; Konishi, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-87,697/A/. 31 Jan 1975. 3p. (In Japanese).

Object: To render the operation for an entire period of time possible without requiring a control rod used to compensate a reactivity loss caused by burnup. Structure: A gap region, whose spacing is variable, is provided within a fuel body of the fuel rod in a reactor so that gas pressure of a volatile nuclear fission product increases as burnup progresses. By utilization of this arrangement, this spacing of the gap is made to be narrowed as burnup progresses to compensate the reactivity loss caused by burnup so that for the entire fuel rod, the reactivity value remains unchanged irrespective of a degree of burnup.

CONTROL SYSTEMS

REFER ALSO TO CITATION(S) 56391, 56769, 56770

56721 (NP—22113) **C-E burnable poison irradiation test program. (CEN No. 50).** (Combustion Engineering, Inc., Windsor, Conn. (USA)). Mar 1977. 41p. Engineering, Inc., Windsor, CT.

The burnable poison material employed by C-E consists of B_4C particles distributed in an Al_2O_3 matrix in concentrations up to 4 weight percent. Over the past four years, the performance of Zircaloy clad burnable poison rods has been examined as part of fuel inspection programs conducted during refueling outages at several C-E PWR's. Rod assembly procedures and specifications have been changed to reduce internal moisture levels. C-E has a continuing development program to improve shim rod design and investigate other burnable poison materials that might offer significant performance gains over the current system. One aspect of this program involves ongoing irradiation experiments which are now being conducted in operating C-E power reactors. Additional details of these programs are presented.

56722 Control material behavior in commercial reactors. Meyer, R.O. (Nuclear Regulatory Commission, Washington, DC); Houston, M.D.; Tokar, M.; Panisko, F.E. *Trans. Am. Nucl. Soc.;* **26**: 172-173(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56723 Absorber materials for fast reactor control applications. Birney, K.R.; Pitner, A.L.; Bourquin, R.D. (Westinghouse Hanford Co., Richland, WA). *Trans. Am. Nucl. Soc.;* **26**: 173-174(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56724 Correlation for boron carbide helium release in fast reactors. Basmajian, J.A.; Pitner, A.L. (Westinghouse Hanford Co., Richland, WA). *Trans. Am. Nucl. Soc.;* **26**: 174(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56725 Measurement of tritium retention in fast-neutron-irradiated boron carbide. Hollenberg, G.W.; Basmajian, J.A. (Westinghouse Hanford Co., Richland, WA). *Trans. Am. Nucl. Soc.;* **26**: 175-176(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56726 Synthesis and fabrication of EuB_6. Pasto, A.E.; Tennery, V.J. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 176(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56727 Irradiation effects in boronated graphite. Beavan, L.A. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **26**: 176-177(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56728 Safe operation of power plants. Pt. 1. State of technology concerning electrotechnical and control equipment in thermal power plants. Freymeyer, P. *VDI (Ver. Dtsch. Ing.) Nachr.;* **31**: No. 1, 11 and 13(Jan 1977). (In German).

2 figs.

Electrotechniques were given a dominating role in the construction of nuclear power plants. The operation of power plants - particularly nuclear power plants - is impossible without the use of electrotechnical and control means. Despite of all reserve in the development and despite of the conservative attitude it is necessary to use the newest results of development and to incite the development ot new electronic systems for the solution of these tasks.

56729 Safe operation of power plants. Pt. 2 . Technical means for the optimal operation of nuclear power plants. Freymeyer, P. *VDI (Ver. Dtsch. Ing.) Nachr.;* **31**: No. 2, 10(Jan 1977). (In German).

1 fig.

Problems of operation and surveillance are discussed as the final part of the essay which began in the VDI-news 1/77 and gives a summarizing view of the situation of the electrotechnical and control equipment in thermal power plants.

56730 Selection and investigation of turbine capacity control system for nuclear power plants. Golovach, E.A. (Cent Boiler and Turbine Inst im. I.I. Polzunov, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 12, 69-74(Dec 1976). (In Russian).

The stability and fast response of P-, I-, PI- capacity controllers are investigated together with the speed regulator and turbine. The investigations were carried out by means of electronic modeling devices in accordance with the system of equations for the K-500-65-1500 turbine. From the point of view of the dynamic characteristics, the best capacity controller is one with the turbine power pulse connected to the P-component of the power controller and one with the generator capacity pulse connected to the I-component of the controller.

56731 Controllability studies for an advanced CANDU boiling light water reactor. Lepp, R.M.; Hinds, H.W. Chalk River, Ontario; Atomic Energy Canada Limited (Dec 1976). 9p.

Bulk controllability studies carried out as part of a conceptual design study of a 1200 MW(e) CANDU boiling-light-water reactor fueled with ^{235}U- or Pu-enriched uranium oxide are outlined. The concept, the various models developed for its simulation on a hybrid computer, and the perturbations used to test system controllability are described. The results show that this concept will have better bulk controllability than similar CANDU-BLW reactors fueled with natural uranium. 11 refs.

56732 Absorber rod to control a nuclear reactor with a charge of spherical fuel elements. Angelini, A.; Handel, H.; Landwehr, H.; Schoening, J.; Hammelmann, K. (to Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.); Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). German(FRG) Patent 1,815,916/B/. 12 Aug 1976. 3p. (In German).

1 fig.

An absorber rod is described which is screw-shaped and can be driven in and out by simultaneous longitudinal and twisting movement. In piles of spherical fuel elements, such as occur in high-temperature reactors, the rod acts as a feed screw where unallowed loads on fuel elements and operating elements or reflector devices are prevented.

56733 Reactor capacity-control technique. Development of KWU/PWR's during the past 10 years and development tendencies. Aleite, W. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). pp 154-159 of In 2. Mitgliederversammlung und Fachtagung der VDI/VDE-Gesellschaft Mess- und Regelungstechnik (GMR). Duesseldorf, Germany, F.R.; VDI (1976). (In German)

From 2. meeting of the members and specialists' meeting of the VDI/VDE-Gesellschaft Mess- und Regelungstechnik (GMR); Wiesbaden, Germany, F.R. (18 - 19 Nov 1976).

6 figs.; 2 tabs.; 6 refs.

The essay gives a historical summary of the development of reactor monitoring, control, limiting, and protection systems for KWU pressurised-water reactors.

56734 Activities of the committee 'Kernreaktorregelung' (nuclear reactor control) in the past few years and future projects. Knecht, O. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). pp 150-153 of In 2. Mitgliederversammlung und Fachtagung der VDI/VDE-Gesellschaft Mess- und Regelungstechnik (GMR). Duesseldorf, Germany, F.R.; VDI (1976). (In German)

From 2. meeting of the members and specialists' meeting of the VDI/VDE-Gesellschaft Mess- und Regelungstechnik (GMR); Wiesbaden, Germany, F.R. (18 - 19 Nov 1976).

6 figs.

Results achieved so far and future projects are portrayed in detail: 1) VDI/VDE 3527-Graphical symbols for nuclear reactor control; 2) VDI/VDE 3528-Special terms and definitons for nuclear reactor control; 3) 8 data sheets on reactor control; 4) VDI/VDE 3530-Characterisation of reactor control rod drives.

56735 Analysis of the control system of a high-capacity turbine for a nuclear power plant. Golovach, E.A. *Energomashinostroenie;* No. 11, 20-21(1976). (In Russian).

A system of speed and capacity control is investigated on the example of a K-500-65-1500 turbine. It makes use of the acceleration correcting signal.

56736 Reactor control system. Motoda, H.; Kiguchi, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-9,495/A/. 26 Feb 1975. 3p. (In Japanese).

Object: To classify data necessary for operation and control of a plurality of reactor units into one for different reactors and the other for control purposes, both data being combined by a data conversion means, to effectively execute calculation required for control of reactors in an effort to reduce labours and to increase in quality of control business. Structure: Operating data from a plurality of reactors are applied to data conversion means through input means, data communication device, and data pool for different reactors, and the applied data is combined with data for different purposes applied from reactor control means to the data conversion means through the data pool for different purposes, after which they are applied in the form of control signals into the plurality of reactors through the data pool for different reactors, data communication device, and reactor control means.

56737 Output control system in a boiling water atomic power plant. Sadakane, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-86,691/A/. 29 Jan 1975. 4p. (In Japanese).

Object: To provide a line in bypass relation with a water heater, a flow rate of said bypass being adjusted to thereby perform quick responsive sub-cool control of a core inlet. Structure: A steam line and a water line are disposed so as to feed water from the reactor core to the water heater via turbine and thence to the core. A line disposed in bypass relation with the water heater arranged in the water line includes a control valve for controlling water passing through the bypass line and a main control for sending a signal to said control valve, said main control receiving loads from the outside, whereby a control signal is transmitted to the control valve, causing water passing through the water heater and water line to the core to be bypassed, a period of time for supplying time to be reduced, and quick response to be enhanced.

56738 Positive safety system with control relay and current regulation functions. Lefebvre, C.; Therond, J.P. (to CEA, 75 - Paris (France)). French Patent 2,294,516/A/. 11 Dec 1974. 15p. (In French).

The positive safety system described, with controlled relay and current regulation functions, is particularly used for controlling the safety absorbers of a nuclear reactor. It includes an input E connected to a periodic current source having a nonzero amplitude in normal operation, a negative current feedback static amperage regulator, the input of which is connected through a galvanic isolation transformer Ta to the input E, a power supply unit A delivering a d.c. voltage, a rectifier R connected to the secondary winding of a transformer Tb delivering a constant current in a load impedance, by connection leads, one of which passes through the static amperage regulator to bring about the negative current feedback.

56739 Positive safety control system. Lefebvre, C.; Therond, J.P. (to CEA, 75 - Paris (France)). French Patent 2,294,474/A/. 11 Dec 1974. 17p. (In French).

The positive safety control system described acts when the value of a signal delivered as a d.c. voltage by a sensor is located outside a bracket of two adjustable values, voltage value for which the system delivers a d.c. output voltage of +1. The system delivers an 0 output value for any other signal value outside this bracket of values or should a circuit component fail. It can be integrated into the protection system of a nuclear reactor to ensure the droping of safety absorbers into the core when the value of one or more physical quantities differs significantly from a reference value.

56740 Positive safety electronic control system and process. Therond, J.P. (to CEA, 75 - Paris (France)). French Patent 2,294,473/A/. 11 Dec 1974. 20p. (In French).

The control process described is for a protection system, particularly of a nuclear reactor, according to which, as from N measurements of one or several physical values measurements are processed by N adaptation members and/or calculations. The median value is selected of the N signals corresponding to N determinations, and the median value is compared with a reference value so that this comparison initiates the triggering off of the desired protective action. This process can be used to carry out the emergency shutdown of a nuclear reactor by dropping safety absorbers into the core.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 57397, 57404, 57405

56741 (ORAU/IEA—76-4) Economic and environmental implications of a U.S. nuclear moratorium, 1985—2010. Whittle, C.E.; Allen, E.L.; Cooper, C.L.; MacPherson, H.G.; Phung, D.L.; Poole, A.D.; Pollard, W.G.; Rotty, R.M.; Treat, N.L.; Weinberg, A.M. (Institute for Energy Analysis, Oak Ridge, Tenn. (USA)). Sep 1976. Contract EY-76-C-05-0033. 77p. Dep. NTIS, PC A06/MF A01.

This study assesses some economic and environmental implications of a nuclear moratorium in the United States. The moratorium is assumed to prohibit new construction starts of reactors after 1980, but to allow continued operation of reactors on line by 1985. Though the main focus is the period between 1980 and 2010, some consideration is given to the implications of a permanent loss of the nuclear option.

56742 Engineer's opinion of the Vermont Yankee court decision. Brunot, W.K. (Pacific Gas and Electric Co., San Francisco). *Trans. Am. Nucl. Soc.;* **26**: 140(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

SITING

REFER ALSO TO CITATION(S) 57467, 57468, 57469, 57470, 57471, 57472, 57473

56743 (EPRI-EA—427-SR) Guidelines for estimating present and forecasting future population distributions surrounding power reactor sites. (Draft of a standard). (Sigma Research, Inc. Richland, Wash. (USA)). Apr 1977. 17p. Dep. NTIS, PC A02/MF A01.

This report presents demographic procedures for estimating and forecasting population totals and distributions within a 50-mile radius of a proposed power plant site. Procedures such as those described are needed to comply with the license application procedure for a proposed power reactor site. The report includes a draft for a prospective American National Standard to estimate present and forecast future population distributions surrounding proposed reactor sites.

56744 Evaluation of earthquake hazard in the central Mississippi Valley. Nuttli, O.W. (St. Louis Univ., MO). *Trans. Am. Nucl. Soc.;* **26**: 126(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56745 Realistic seismic safety for nuclear plants. Blume, J.A. (John A. Blume and Associates, Engineers, San Francisco). *Trans. Am. Nucl. Soc.;* **26**: 130-131(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56746 INSITE: information on nuclear sites data system. Huber, C.C.; Livengood, C.D.; Samsa, M.E.; Wolsko, T.D. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 136(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56747 **Social aspects of nuclear power plant siting.** White, W.T. (Dames and Moore, White Plains, NY). *Trans. Am. Nucl. Soc.;* **26**: 136-137(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56748 **Recent state laws regulating power facility siting.** Evans, V.A. (Gilbert/Commonwealth, Jackson, Mich). *Nucl. Technol.;* **31**: No. 3, 319-325(Dec 1976).

This paper surveys and compares the provisions of various state laws for power facility site review and certification, and discusses the need for further research on state power facility siting issues. It provides a recent broad overview of state siting requirements that will be useful to the utility industry in planning and licensing power developments.

56749 (NP-tr—1974) **Data for the evaluation of the properties of sites for nuclear power plants in consideration of reactor safety and radiation protection.** (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)). 1976. Translation of Bewertungsdaten fuer die eigenschaften von kernkraftwerksstandorten aus der sicht von reaktorsicherheit und strahlenschutz. 27p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Data are presented for the evaluation of properties of sites for nuclear power plants with consideration given to reactor safety and radiation protection.

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 56870, 57371, 57372, 57373

56750 (IKE—6-104) **Flow of radioactive gases through ground layers.** Dinkelacker, A.; Bernnat, W. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik). Sep 1976. 71p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

19 figs.; 3 tabs.; 10 refs.

In connection with the proposed underground construction of nuclear power stations, this study investigates how the radioactive gases released into the surrounding ground layers during a hypothetical reactor accident (LOCA) diffuse in this porous medium. To calculate the one-dimensional pressure pattern in the ground layers in cartesion cylinder or spherical coordinates as well as the gas mass escaping on the earth's surface, a computer programme has been worked out which solves the equations describing the flow by means of an explicite difference method. Test calculations show that the retention properties of the geological materials are governed to a high degree by their permeability.

56751 **Remote monitoring system for nuclear reactors.** Eder, E. (Bayer Landesamt fuer Umweltschutz, Munich, Ger). *Kerntechnik;* **19**: No. 1, 21-26(Jan 1977).

The Department for Environmental Protection of the State of Bavaria intends to build in Bavaria a remote monitoring system for nuclear reactors (KFU). The functions of the KFU will include a continuous computer-controlled monitoring of radioactive emissions, of the meteorological parameters and of certain operating parameters of power reactors. In addition, the radioactive immissions in the vicinity of nuclear power plants will be determined by means of actual calculations. This will make it possible, in the event of an accident, to arrive rapidly at an evaluation of the conditions in the regions which might be at risk. The implementation of the first stage of the KFU is scheduled for completion by mid-1978. 3 refs.

CHEMICAL AND THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 56239, 57364, 57395, 57446, 57454

56752 **Atmospheric impacts of wet cooling systems for power plants.** Carson, J.E. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 114-115(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56753 **Offshore environmental monitoring program for a proposed nuclear power plant in Islote, Puerto Rico: operations and planning.** Cochrane, D.A. Jr. (OECS Corp., Lafayette, LA). *Trans. Am. Nucl. Soc.;* **26**: 124-125(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 56474, 56766, 56778, 56815, 56847

56754 (CONF-760503—P1, pp 271-277) **Sorption of radionuclides on sodium sampling vessels.** Stamm, H.H. (Kernforschungszentrum, Karlsruhe, Ger.). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Determination of radionuclides in KNK primary sodium yielded different results when ceramic crucibles instead of nickel crucibles were used for sodium sampling. It was shown that adsorption of some radionuclides on nickel crucibles was the reason for this effect. Small cylinders and metal coupons were introduced into the KNK primary sodium sampling station for radionuclide deposition studies. These deposition samples, made of different types of stainless steel, nickel, tantalum, titanium, and molybdenum, were exposed to the contaminated, flowing primary coolant for times up to 24 hours. Gamma spectrometric measurements indicated a strong adsorption of ^{65}Zn on all nickel samples; the activities of ^{51}Cr, ^{54}Mn, ^{60}Co, and at low temperatures (473°K) even of /sup 110m/Ag were higher on nickel samples than on any other material exposed to the primary sodium. These results were confirmed for the adsorption of radionuclides on crucibles of various metals. Consequently, stainless steel crucibles will be used for sampling primary sodium in order to determine radionuclides at KNK-II.

56755 (CRBRP-ARD—0164) **Clinch River Breeder Reactor Plant. Irradiated EBR-II duct crushing test and analysis.** Garkisch, H.D.; Fish, R.L.; Haglund, D.R. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Apr 1977. Contract EY-76-C-15-0003;EY-76-C-15-2395. 167p. .

The test results are reported. Crush tests were performed on EBR-II duct sections to simulate and identify failure modes under the seismic, transverse loading conditions. Tensile and bend tests were conducted to provide supportive stress-strain information that could be used to help interpret and analyze the duct crush test results. The tests were conducted on material irradiated at 735 to 835°F to neutron fluences ranging from 3.9 to 10.2 x 10^{22} n/cm^2 (E $<$ 0.1 MeV). The analysis and the comparison of test and analysis results are reported. The stress-strain curves of the tensile test were used in the plastic analysis of the bending and duct specimens. Classical plastic limit analysis was employed to demonstrate that these tools, which can be used for ductile materials, can also be employed for highly irradiated structures. Finite element analyses of the specimens were performed to estimate the plastic failure strain at the observed failure locations. This analysis allowed a comparison of measured and analyzed bending deformation of the bend and the duct specimen using tensile stress-strain curves.

56756 (IS—4139) **Environmental monitoring at Ames Laboratory: calendar year 1976.** Voss, M.D. (Ames Lab., Iowa (USA)). Apr 1977. Contract W-7405-ENG-82. 69p. Dep. NTIS, PC A04/MF A01.

The effluent and environmental monitoring program at the Ames Laboratory is summarized. An inventory of the radioactive materials and certain chemicals released to the environment is included. A summary of the radioactivity found in the environment is presented. An estimate of the radiation dose to the public resulting from the operations of the Ames Laboratory is stated.

56757 (TID—27663) **LOFT experiment operating specification. LOFT nonnuclear experiment series L-1. EOS Volume 1. Appendix A. Revision 2. Change No. L1-A-1.** (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Aug 1974. Contract EY-76-C-07-1375. 51p. Dep. NTIS, PC A04/MF A01.

Volume 1 of the EOS describes the overall LOFT experimental program plan in sufficient detail to guide the preparation of specifications for individual experiments, and provides a common basis for mutual understanding between AEC, TRSP, and LOFT on details of the experimental program which may not have been previously addressed. Volume 1 specifies, in general, the important features, basic content, and objectives of each experiment series and describes general requirements for data handling. Appendices to Volume 1 specify initial condition values for those system variables which (1) significantly influence reactor plant characteristics during blowdown and reflood, and (2) are currently planned to be varied from experiment to experiment. These appendices will provide the rationale used to select initial condition values for these variables and supply results of analyses utilized in experiment sequencing and parameter value specification.

56758 Flow-induced bending of rectangular plates. Kim, Y.T.; Scarton, H.A. (GE, Lynn, Mass). *Am. Soc. Mech. Eng., [Pap.]*: No. 77-APM-14, vp(15 Jun 1977).

An analysis of flow induced bending of rectangular plates simply supported on two sides and free on the leading and trailing edges, with viscous entry flows differing in flow rate on top and bottom, is presented. Viscous shear is shown to be important in modifying the plate deflection near the leading edge. The flow rate is maximized and deflection minimized by using relatively small length-to-width ratios. The results are directly applicable to stacked rectangular fuel-bearing plates in nuclear reactors. 18 refs.

56759 Monte Carlo calculations of cadmium cutoff energies and an ansatz formula. Fiarman, S.; Sher, R. (Stanford Univ., CA). *Nucl. Sci. Eng.;* **63**: No. 2, 208-212(Jun 1977).

A Monte Carlo program, CDCUTOF, has been written to evaluate the cadmium cutoff energy of several cadmium-covered foils in pillbox geometries. Comparison with analytical results for simple geometries were also made. In addition, a general formula for roughly calculating the cadmium cutoff energy is given that agrees with analytical results to within 0.1 eV.

56760 Design of the FFTF fuel storage facility (FSF). Asquith, J.G.; Maki, L.M. (Atomics International, Canoga Park, CA). *Trans. Am. Nucl. Soc.;* **26**: 259-260(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56761 Effects of RELAP4/MOD5 modeling of the LOFT pressurizer. White, J.R. (EG and G Idaho, Inc., Idaho Falls, ID); Holmstrom, H.L.O. *Trans. Am. Nucl. Soc.;* **26**: 327-329(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56762 German-British-French high flux reactor in Grenoble and its research program. Moessbauer, R.L. *Chem. Ztg.;* **100**: No. 12, 543-544(Dec 1976). (In German).

Short communication only.

56763 Neutron radiography at the FR 2 in operation. Schuelkem, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Reaktorbetrieb und Technik). *KFK Nachr.;* **8**: No. 2, . 16-17(1976). (In German).

3 figs.; 2 tabs.

The neutron radiography installation for investigating highly radioactive reactor components and experimental insets at the FR 2 is described. Collimator data and ways of operation as well as examples of neutron-radiographic records of fuel rod specimens and sandwich plates are described.

PLUTONIUM AND ISOTOPE PRODUCTION REACTORS

56764 (AED-Conf—76-556-013) **Irradiation and post-irradiation examination techniques for reactor pressure vessel steels at GKSS.** Ahlf, J.; Schmitt, F.J. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Werkstofftechnologie und Chemie). 1976. 11p. (In German). (CONF-7609138—). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Technical meeting on radiation exposure and damage of reactor components outside the reactor core; Stuttgart, German, Federal Republic of (F.R. Germany) (23 Sep 1976).

14 figs.; 10 refs.

For reactor pressure vessel steel irradiations, especially for big fracture mechanics specimens, FRG-2 offers favourable conditions because of its good accessibility. Well proven irradiation devices for small specimens and for corrosion experiments are available. Rigs for fracture mechanics specimens are being developed; pretests for their design are being performed at present. For materials testing of irradiated specimens two impact testing machines, a 50 kN tear testing machine and a drop weight machine, further a hardness tester and several optical systems are installed in the hot laboratory. The installation of a 250 t tear testing machine is being prepared. As yet irradiation experiments on steels 26 NiCrMoV 1 4 3, 15 MnMoNiV 5 3, 13 CrMo 4 4 and ASTM A533 B have been performed, on the latter also recovery heat treatments and experiments with small fracture mechanics specimens.

PROPULSION REACTORS

56765 Probabilistic assessment of collisions involving nuclear vessels. Heller, A.S. (Babcock and Wilcox Co., Lynchburg, VA). *Trans. Am. Nucl. Soc.;* **26**: 137-140(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

REACTOR SAFETY

REFER ALSO TO CITATION(S) 56551, 56657, 56938

56766 (ANL—76-130) **Final report on Test L4, a loss-of-flow experiment.** Eberhart, J.G.; Lo, R.K.; Barts, E.W. (Argonne National Lab., Ill. (USA)). Dec 1976. Contract W-31-109-ENG-38. 80p. .

The behavior of FTR-type, mixed-oxide, preirradiated, "high-power-structure" fuel during a simulation of an FTR loss-of-flow accident was studied in the Mark-IIA integral TREAT loop. Analysis of the data leads to a postulated scenario (sequence and timing) of events in the test. This scenario is presented, together with the calculated timing of events obtained by use of SAS code. The motion of the seven-element bundle started during the preheat phase, and the bundle moved coherently toward the pump. As temperature rose, the fuel motion became increasingly incoherent, and fuel moved away from the pump. Fuel slumping occurred at the middle third of the central fuel column. The top third did not slump, but was swollen from fission-gas expansion. The stainless steel cladding melted shortly after dryout of the sodium film and generally flowed downward. The unsupported fuel pellets came in contact with and subsequently melted the fluted tube. The apparent thinness of a steel blockage at the bottom of the fuel column suggested that this blockage might not have been completed. There were two eructations: one at 26.9 sec, the other at 31.3 sec.

56767 (BMI-NUREG—1968) **Steam—water mixing and system hydrodynamics program. Task 4. Quarterly progress report, October—December 1976.** Carbiener, W.A.; Cudnik, R.A.; Flanigan, L.J.; Carr, J.A.; Denning, R.S. (Battelle Columbus Labs., Ohio (USA)). Feb 1977. 52p. Dep. NTIS, PC A04/MF A01.

Experimental studies are being conducted in scale models of a four loop pressurized water reactor at pressures to 60 psig to extend the understanding of steam-water interaction phenomena and processes associated with a loss-of-coolant accident. Downcomer flow resistance effects studies were carried out in the 1/15-scale, transparent vessel model. In conjunction with the alternate cold leg arrangement penetration studies, lower plenum sweepout studies were conducted with simulated vendor lower core barrel hardware. Construction of the 2/15-scale model, low pressure facility continued with completion scheduled for the second quarter of FY 1977. All piping and major components have been installed in the facility and installation of model instrumentation has been initiated. Planning efforts associated with a 2/15-scale model, high pressure facility design and research program were carried out and presented to NRC in October in the form of a detailed Program Plan.

56768 (BMI-NUREG—1969) **Aerosol measurements and modeling for fast reactor safety. Task 7. Quarterly progress report, October 1—December 31, 1976.** Gieseke, J.A.; Jordan, H.; Webb, P.R.; Reed, L.D. (Battelle Columbus Labs., Ohio (USA)). 21 Mar 1977. 18p. Dep. NTIS, PC A02/MF A01.

Technical progress is described on HAARM-2 computer code improvements, measurements of sodium oxide agglomerate characteristics, and PuO_2 aerosol simulation studies.

56769 (CENPD—182(Pt.1)) **Instrumentation qualification. Seismic qualification of C-E instrumentation equipment. Part One.** (Combustion Engineering, Inc., Windsor, Conn. (USA)). May 1977. vp. Engineering, Inc., Windsor, CT.

A summary of the C-E seismic qualification program utilized to demonstrate the seismic design adequacy of the instrumentation and control equipment used in C-E supplied Nuclear Steam Supply Systems (NSSS) is presented. The report is divided into two parts. Part One includes the equipment seismic requirements and a description of the qualification methods. Part Two lists the specific equipment by nuclear station in which it is used and the equipment test results are summarized in a standard data sheet format to facilitate review. The seismic requirements are based on individual contract commitments with C-E customers and the NRC Standard Review Plan, Section 3.10 "Seismic Qualification of Category I Instrumentation and Electrical Equipment." Equipment is qualified for use in a seismic environment where damage potential to the equipment is less than or equal to that simulated seismic environment to which it has been qualified. The anticipated Safe Shutdown Earthquake (SSE) environment at the inservice location of equipment should be con-

firmed by each applicant as not exceeding that to which it is qualified.

56770 (CENPD—182(Pt.2)) **Instrumentation qualification. Seismic qualification of C-E instrumentation equipment. Part Two.** (Combustion Engineering, Inc., Windsor, Conn. (USA)). May 1977. 112p. Engineering, Inc., Windsor, CT.

56771 (CONF-770625—3) **Use of reliability in the LMFBR industry.** Penland, J.R.; Smith, A.M.; Goeser, D.K. (Clinch River Breeder Reactor Plant Project Office, Oak Ridge, Tenn. (USA)). 1977. 44p. Dep. NTIS, PC A03/MF A01.

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, Tennessee, United States of America (USA) (20 Jun 1977).

This mission of a Reliability Program for an LMFBR should be to enhance the design and operational characteristics relative to safety and to plant availability. Successful accomplishment of this mission requires proper integration of several reliability engineering tasks--analysis, testing, parts controls and program controls. Such integration requires, in turn, that the program be structured, planned and managed. This paper describes the technical integration necessary and the management activities required to achieve mission success for LMFBR's.

56772 (COO—4040-1) **Attenuation of radiological consequences from CDA's by radiation. Progress report, October 1, 1976—September 31, 1977.** Chan, S.H. (Wisconsin Univ., Milwaukee (USA). Dept. of Energetics). 4 May 1977. Contract E(11-1)-4040. 18p. Dep. NTIS, PC A02/MF A01.

This technical progress report summarizes the research work accomplished during the first six months of the investigation on the significance of radiation heat transfer in attenuating the radiological consequences from LMFBR core disruptive accidents. Considerable progress has been made in modeling and computing the effects of radiative cooling on a rising HCDA bubble buoyant through a sodium pool. Our results reveal that most of the fuel vapor within the bubble can be effectively condensed out by radiating cooling. The finding has a profound implication as it could lead to a substantial reduction in subsequent aerosal releases.

56773 (CREARE-TN—255) **Effect of superheated walls on plenum filling at 1/15 scale. Quarterly progress report, October 1, 1976—December 31, 1976.** Block, J.A.; Crowley, C.J. (Creare, Inc., Hanover, N.H. (USA)). Mar 1977. 24p. Dep. NTIS, PC A03/MF A01.

Results of experiments in a 1/15-scale, cylindrical elevated pressure PWR-model test vessel are described. These tests form part of a program to develop an analytical and empirical model for plenum filling. During the quarter facility modifications included the addition of simulated loops and a variable resistance in the core region. Testing included coupled cold leg steam and condensation induced transient tests. The effect of ECC injection on steam flows is discussed and examples are presented. The effect of superheated downcomer walls on end-of-bypass and rates of plenum refill in earlier steady-stream flow tests is also discussed.

56774 (EURFNR—1400) **Evaporation studies of liquid oxide fuel at very high temperatures using laser beam heating.** Bober, M.; Breitung, W.; Karow, H.U.; Schretzmann, K. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Nov 1976. 53p. (KFK—2366). Dep. NTIS (US Sales Only), PC A04/MF A01.

Work performed under United States—Euratom Fast Reactor Exchange Program.

Safety analysis of fast reactors requires knowledge of the evaporation behavior and the total vapor pressure of oxide fuel materials in the temperature region from 3000 K upwards. Evaporation experiments with oxide fuel were carried out based on laser beam heating of the fuel specimen surface. Rectangular laser pulses of 1 to 10 msec pulse length were used, cut out from the continuous beam of a high-power CO_2 laser. The measured quantities are the recoil momentum of the target, the evaporation area, the evaporation time and the mass and momentum of the supersonic vapor jet expanding into vacuum, and the thermal radiation density of the evaporating surface. From the mechanical measuring quantities were derived the vapor pressure of the target material and, in a first approach, also the evaporation temperature by applying a gas dynamic evaluation model. In a second approach, after having measured the spectral emissivity of liquid UO_2 at 633 nm by use of a He-Ne-laser, the evaporation temperature at the liquid surface was derived also from its thermal radiation. For the determination of the vapor pressure from the measured quantities a gas dynamic evaluation model has been developed. An application limit of the measuring technique is given by onset of plasma interaction of the vapor plume with the incident laser beam at temperatures above 4500 K. Movement of liquid material in the laser crater caused by the reactor pressure of the vapor jet does not disturb the vapor pressure measurements.

56775 (GA-A—14205) **Evaluation of integral experiments and potential test facilities for future HTGR fission product safety research.** Chawla, O.P.; Barsell, A.W. (General Atomic Co., San Diego, Calif. (USA)). May 1977. Contract EY-76-C-03-0167. vp. Dep. NTIS, PC A05/MF A01.

Test facilities, existing and proposed, domestic and foreign, in-pile and out-of-pile, are surveyed to establish options for large-scale integral experiments in ERDA-funded safety R and D programs. Based on justification stemming from HTGR probabilistic risk assessment and licensing needs, recommendations are made for integral test simulation of the core heatup, depressurization, and steam ingress events. Construction of a special electrical heating apparatus to be used in a shut-down reactor core is recommended as economically and technically optimum for core heatup, while an in-pile simulation using the proposed COMEDIE (aternately AIDA 4 or Grist) loop is recommended for depressurization and steam ingress accidents.

56776 (GEFR—13923-18) **Fuel rod mechanics and failure analysis. Eighteenth quarterly report, November—December 1976 and January 1977.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Feb 1977. Contract EY-76-C-03-0893-002. 46p. .

The objective of the work reported under this program is to model fuel rod performance and cladding failure under hypothetical transient conditions, and to validate these models using data from both integral fuel rod experiments and differential in-reactor and out-of-reactor experiments.

56777 (GEFR—14034-10) **Radiological assessment models. Tenth quarterly report, December 1976—February 1977.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Mar 1977. Contract EY-76-C-3-0893-015. vp. .

The objectives of the program are to develop models based upon analysis and experiment to determine: (1) the amount and the characteristics of radiological materials discharged energetically from the core, transported to the cover-gas space and available for leakage from the reactor vessel, and (2) the long-term radiological source resulting from a core melt-through as a result of hypothetical core disruptive accidents in liquid metal fast breeder reactors. During this reporting period, a fuel vapor bubble transport model was developed in which radiation was assumed to be the predominant mode of energy transfer. The effect of sodium emissivity and the number of bubbles on fuel vapor condensation was investigated parametrically. Experimental data which may be applicable to the evaluation of fuel particle sparging were examined.

56778 (HEDL-TME—77-26) **Comparison of 2D and 3D diffusion theory codes for transition-phase modeling of distorted subassemblies.** O'Dell, L.D.; Wilson, R.E. (Hanford Engineering Development Lab., Richland, Wash. (USA)). May 1977. Contract EY-76-C-14-2170. 28p. .

To analyze the combined transient overpower and loss-of-flow accident, it may be necessary to recalculate the neutronics data once a significant amount of material has relocated in the core. Recalculating the data at several points in time during the course of a single analysis using the original methods employed to obtain the neutronics data [fine-mesh three-dimensional (3D) diffusion theory] would be prohibitively expensive. Therefore, a study has been performed to examine the possibilities of using either a fine-mesh two-dimensional (2D) diffusion theory calculation or a coarse-mesh three-dimensional (3D) diffusion theory calculation.

56779 (IRS-F—33) **Reports on the research projects in the field of reactor safety sponsored by the Federal Ministry of Science and Technology. Period under report: July 1st to September 30th, 1976.** (SEE CODE- 2795680 Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (Germany, F.R.)). Dec 1976. 335p. (In German). Dep. NTIS (US Sales Only), PC A15/MF A01.

With figs. and tabs.

Investigations on the safety of light water reactors (LWR) being performed in the framework of the safety program 'Reactor Safety' are sponsored by the Bundesminister fuer Forschung und Technologie (BMFT - Secretary of State for Research and Technology). Objective of this program is to continue improving the safety of LWR, in order to minimize the risk for the environment. With grant assistance from the Bundesminister des Innern (BMI - Secretary of State for Home Affairs) research contrcts in the field of reactor safety are being performed. Results of these projects should contribute to resolve questions arising nuclear licensing procedures. The Forschungsbetreuung (FB - research supervision department) at the Institute for Reactor Safety (IRS), as consultants to BMFT and BMI, provides information about the progress of investigations. Individual reports will be prepared and put into standard forms by the research contractors. Each report gives information on: 1) the work accomplished, 2) the results obtained, 3) the work planned to be continued. Initial reports of research projects describe in addition the purpose of the work. A BMFT-research program on the safety

of Fast Breeders (Schneller Brutreaktor - SRB) is presently under discussion. In order to define several problems, investigations included in the present compilation (RS 139, 140, 143, 162) will be previously performed.

56780 (IRS-W—24) **Calculation of the stationary mass velocity of steam mixtures and of the recoil forces occurring during LOCA.** Pana, P. (SEE CODE- 2795680 Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (Germany, F.R.)). Nov 1976. 137p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

48 figs.; 9 tabs.; 11 refs.

The best known theories for steam flow (e.g. after pipe rupture within the primary coolant loop of a nuclear power plant) are discussed, namely the theory of the modified-Bernoulli-equation for the subcooled region, the Moody theory and the homogenious euquilibrium theory for the steam-water region, and the theory of the perfect gas for the superheated region. The calculated mass velocity and thrust coefficient is shown for the whole h-s chart, including various initial pressures and Zeta values as parameter. The comparison of the results leads to important conclusions concerning conservatism and appropreateness of the considered theories for friction and frictionless flow.

56781 (JAERI-M—6538) **Oxygen concentration distribution in β-phase of the Zry-4 cladding during Zr-steam reaction at LOCA.** Suzuki, M. (Japan Atomic Energy Research Inst., Tokyo). May 1976. 27p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

To examine the ductility decrease of the Zry-4 cladding by Zr-Steam reaction at LOCA, the oxygen concentration distribution in β-phase calculated is compared with the experimental one by ring compression test. The ductility decreases generally with concentration of oxygen in the β-phase, with some exceptions at a higher temperature. The fracture surface in ring compression test shows an intergranular cracking, in support of some assumptions made in the calculational model.

56782 (JAERI-M—6539) **HYDY-B1 CODE: calculational model for core thermo-hydraulics during a loss-of-coolant accident.** Asahi, Y. (Japan Atomic Energy Research Inst., Tokyo). Apr 1976. 26p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The HYDY-B1 digital computer code calculates thermo-hydraulic response of reactor channel(s) during the decompression phases of loss-of-coolant accidents (LOCA). The HYDY-B1 code solves, among other things, the one-dimensional heat conduction equation for a single rod, the one-dimensional equations of conservation of energy, mass, and momentum for the channel flow as well as reactor dynamics equation. Experience gained thus far in computation by the HYDY-B1 code has shown very good numerical stability.

56783 (JAERI-M—6602) **Behavior of inner surface oxidation of the zircaloy cladding tube in a loss-of-coolant accident.** Honma, K.; Hashimoto, M.; Furuta, T.; Otomo, T.; Kawasaki, S. (Japan Atomic Energy Research Inst., Tokyo). Jun 1976. 21p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

In simulation of inner surface oxidation of the fuel cladding in a LOCA, oxidation of the zircaloy cladding in stagnant steam has been studied. Weight gain of the oxidized specimen in stagnant steam is less than that of the oxidized specimen in flowing steam. Ring compression test shows, however, that ductility loss of the oxidized specimen in stagnant steam is more than that of the oxidized specimen in flowing steam despite its less oxidation. The oxidized specimen in stagnant steam absorbs hydrogen but the oxidized specimen in flowing steam doesn't. The ductility is decreased with the hydrogen content.

56784 (LA—6813-MS) **Bayesian Zero-Failure (BAZE) reliability demonstration testing procedure for components of nuclear reactor safety systems.** Waller, R.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1977. Contract W-7405-ENG-36. 72p. Dep. NTIS, PC A05/MF A01.

A Bayesian-Zero-Failure (BAZE) reliability demonstration testing procedure is presented. The method is developed for an exponential failure-time model and a gamma prior distribution on the failure-rate. A simple graphical approach using percentiles is used to fit the prior distribution. The procedure is given in an easily applied step-by-step form which does not require the use of a computer for its implementation. The BAZE approach is used to obtain sample test plans for selected components of nuclear reactor safety systems.

56785 (LA-NUREG—6623) **K-FIX: a computer program for transient, two-dimensional, two-fluid flow.** Rivard, W.C.; Torrey, M.D. (comps.). (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1976. Contract W-7405-ENG-36. 129p. Dep. NTIS, PC A07/MF A01.

The transient dynamics of two-dimensional, two-phase flow with interfacial exchange are calculated at all flow speeds using the K-FIX program. Each phase is described in terms of its own density, velocity, and temperature. The six field equations for the two phases couple through mass, momentum, and energy exchange. The equations are solved using an Eulerian finite difference technique that implicitly couples the rates of phase transitions, momentum, and energy exchange to determination of the pressure, density, and velocity fields. The implicit solution is accomplished iteratively without linearizing the equations, thus eliminating the need for numerous derivative terms. K-FIX is written in a highly modular form to be easily adaptable to a variety of problems. It is applied to growth of an isolated steam bubble in a superheated water pool.

56786 (ORNL/NUREG/NSIC—135) **Bibliography of reports on research sponsored by the NRC Office of Nuclear Regulatory Research, July—December 1976.** Buchanan, J.R. (Oak Ridge National Lab., Tenn. (USA)). 1 Mar 1977. Contract W-7405-ENG-26;INA-NRC-40-551-75-40-552-75. 94p. Dep. NTIS, PC A06/MF A01.

A bibliography of 148 reports published by contractors of the NRC Office of Nuclear Regulatory Research during the period July through December 1976 is presented along with abstracts from the Nuclear Safety Information Center computer file. The bibliography has been sorted into the subject categories used by NRC to organize the research program. Within the subject categories, the reports are sorted by contractor organization and then chronologically. A brief description of the NRC research program precedes the bibliography.

56787 (ORNL/NUREG/NSIC—136) **Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I—VI.** Heddleson, F.A. (Oak Ridge National Lab., Tenn. (USA)). 13 May 1977. Contract W-7405-ENG-26. 88p. Dep. NTIS, PC A06/MF A01.

Design data, safety features, and site characteristics are summarized for 12 nuclear power units in 6 power stations in the United States. Six pages of data are presented for each station, consisting of thermal-hydraulic and nuclear factors, containment features, emergency-core-cooling systems, site features, circulating water system data, and miscellaneous factors. In addition, an aerial perspective is presented for each plant. This volume covers plants with docket numbers 50-553 through 50-569 (Phipps Bend, Black Fox, Yellow Creek, and NEP) and two earlier plants not previously reported--Hope Creek (50-354, 50-355) and WPPSS 1 and 4 (50-460, 50-513). Indexes for this volume and the five earlier volumes are presented in three forms--by docket number, by plant name, and by participating utility.

56788 (ORNL/TM—5322) **ORSLAP: a digital computer program for dynamic simulation of a multinode sodium loop during transients.** Hedrick, R.A.; White, J.S. (Oak Ridge National Lab., Tenn. (USA)). 4 May 1977. Contract W-7405-ENG-26. 86p. .

This report describes the ORSLAP computer program developed for analyzing flow transients in the Thermal-Hydraulic Out-of-Reactor Safety (THORS) [formerly the Fuel Failure Mockup (FFM)] loop at the Oak Ridge National Laboratory. The method of solution is described, including the equation of state for sodium; conservation equations for mass, energy, and momentum; loop component models; and the filtering technique. A complete user's guide and a sample problem are also included. The loop component models are general, allowing the program to be used for any sodium-cooled thermal-hydraulic system with similar components.

56789 (PB—265020) **Some probabilistic aspects of the seismic risk of nuclear reactors.** Hsieh, T.; Okrent, D. (California Univ., Los Angeles (USA). Dept. of Energy and Kinetics). Dec 1976. 85p. (UCLA-ENG—76113). NTIS PC A05/MF A01.

The potential for existing cracks in piping systems to grow to critical size and cause system failure during a severe earthquake was examined, and the critical crack size based on linear elastic mechanics was reviewed. A simple and crude method of relating the initial crack size, the range of strain produced in a component, and the number of cycles to failure, was proposed and discussed. The significance of piping failure due to ordinary crack growth other than the intergranular stress corrosion under seismic loading was found to be comparable with the potential for failure due to crack growth under severe seismic loads. A simplified piping system with only a few snubbers and hangers as seismic restraints was devised. The inverse of the maximum Von Mises ratios at a few nodal points of the piping system was used as the basis for indicating the change in safety factor due to piping restraint failures. The potential importance of seismic events leading to a core melt accident was examined by factoring the effect of design errors and system degradation into an estimate of the probability of a core-melt accident due to seismic events.

56790 (PB—265098) **Decision-table development for use with the CAT code for the automated fault-tree construction.** Wu, J.S.; Salem, S.L.; Apostolakis, G.E. (California Univ., Los Angeles (USA). Dept. of Energy and Kinetics). Jan 1977. 123p. (UCLA-ENG—7711). NTIS PC A06/MF A01.

A library of decision tables to be used in connection with the CAT computer code for the automated construction of fault trees is presented. A decision table is constructed for each component type describing the output of the component in terms of its inputs and its internal states. In addition, a modification of the CAT code that couples it with a fault tree analysis code is presented. This report represents one aspect of a study entitled, 'A General Evaluation Approach to Risk-Benefit for Large Technological Systems, and Its Application to Nuclear Power.'

56791 (PB—265099) **On the probability of loss of dc power following ac failure in a nuclear power plant.** Chun, J.; Apostolakis, G.E. (California Univ., Los Angeles (USA). Dept. of Energy and Kinetics). Dec 1976. 43p. (UCLA-ENG—76112). NTIS PC A03/MF A01.

The objective of the study is to estimate the probability of failure of the battery system of a nuclear power plant due to loss of ventilation in the battery room during ac blackout. This is part of the more general problem of the interaction between non-safety systems and safety systems. The emergency battery system and the associated ventilation system are a pair of interactive systems, the former being a safety system and the latter a non-safety system. Described are: (1) the emergency battery room; (2) the heat sources in the room following ac blackout; (3) the overall problem of insufficient power in the plant, the frequency of loss of ac power, and the time-dependent probability of nonrestoration of ac power; (4) the probabilistic approach to the problem; and (5) the thermal models used to evaluate the temperature rise in the battery room. A series of tables show the failure probabilities at several times and for different values of the standard deviations of the parameters of importance.

56792 (SAN/1011—103) **Equivalent viscous damping for seismic analyses of nuclear plants.** Werner, S.D.; Reddy, D.P. (Agbabian Associates, El Segundo, Calif. (USA)). 1 Apr 1975. Contract EY-76-C-03-1011. 79p. .

This report summarizes current procedures used to represent energy losses as equivalent viscous damping in dynamic seismic analyses of nuclear power plants. A general discussion is provided of the procedures used for formulating damping matrices. Idealized forms for direct use in normal mode analyses that include Rayleigh, Caughey, Wilson and Penzier, and Nielsen techniques are discussed. Analytical and experimental techniques for defining equivalent viscous damping ratios are then presented. The analytical approaches of Jacobsen, Hudson, Jennings, and Mayer and Mowbray are discussed, and experimental methods based on free vibration, steady state and random motion test measurements are described. Estimated damping values determined from field measurements are summarized for comparison with currently used values recommended for nuclear power plant design.

56793 (SAN/1011—106) **Determination of equivalent response cycles for use in earthquake-induced fatigue analyses.** Ts'ao, H.S.; Werner, S.D. (Agbabian Associates, El Segundo, Calif. (USA)). 30 May 1977. Contract EY-76-C-03-1011. 48p. .

This report considers two important steps in the overall procedure of estimating the cyclic loads resulting from seismic effects and estimating the fatigue resistance of nuclear plant elements. These are the estimation of the number and size of earthquake events that may occur during the service life of the plant and the definition of equivalent cyclic response cycles. A probabilistic procedure is demonstrated for selecting the number of seismic events to be considered in the fatigue analysis so that the risk of the multiple events selected will be consistent with the risk associated with other aspects of the seismic design criteria. Procedures for estimating equivalent response cycles are described. It is concluded that the range-pair and rain-flow methods provide the most consistent results.

56794 (TID—27639) **Gamma heated subassembly for sodium boiling experiments.** Artus, S.C. (Washington Univ., Seattle (USA)). 1975. Contract EY-76-S-05-3363. 79p. Dep. NTIS, PC A05/MF A01.

Thesis.

The design of a system to boil sodium in an LMFBR is examined. This design should be regarded as a first step in a series of boiling experiments. The reactor chosen for the design of the boiling apparatus is the Experimental Breeder Reactor-II (EBR-II), located at the National Reactor Testing Station in Idaho. Criteria broadly classified as design objectives and design requirements are discussed.

56795 (UCRL—50045-77-1) **Reactor containment analysis for BWR suppression systems. Progress report for January—March 1977.** Bowman, B.R.; Edwards, L.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Jun 1977. Contract W-7405-ENG-48. 24p. Dep. NTIS, PC A05/MF A01.

Progress during the period included improvement of the CHAMP code for simulation of BWR pressure suppression systems and development of an incompressible hydrodynamics code.

56796 (UCRL—79277) **Comparing structural loads in large pools evaluated with the LUSH code and current design methods.** Dong, R.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Nov 1976. Contract W-7405-ENG-48. 17p. (CONF-770807—10). Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

Large pools for storing spent fuel elements from nuclear reactors are being proposed to augment the present storage capacity of pools located at nuclear power plants and fuel reprocessing plants. These pools will be part of either independent spent fuel storage installations or large reprocessing plants. Because of the large size of the pools, seismic loads are of significant interest, and in particular the adequacy of current design methods for calculating seismic loads was of special concern. An evaluation of design methods representative of current practice was carried out, and the results are summarized. The evaluation was based on a comparison of total structural loads obtained by these methods with those obtained using the LUSH code. The LUSH code offered a combination of latest technologies in structural analysis involving soil-structure interaction.

56797 (XN—76-47(NP)) **Combined seismic-LOCA mechanical evaluation for Exxon Nuclear 15 x 15 reload fuel for Westinghouse PWR's.** Brown, C.A. (Exxon Nuclear Co., Richland, Wash. (USA)). May 1977. 153p. Nuclear Co., Inc., Richland, WA.

This report describes the combined seismic-LOCA analysis of the Exxon Nuclear Company (ENC) 15 x 15 reload fuel assemblies for use in Westinghouse PWR's. The objective of this analysis is to evaluate fuel rod stresses, guide tube stresses, and interactive grid spacer loads and deflections during a combined seismic-LOCA event to verify that the fuel remains "coolable" following such an event.

56798 **Best-judgment analysis of emergency core cooling system performance.** Kessler, T.C.; Fader, G.B. (Combustion Engineering, Inc., Windsor, CT). *Nucl. Technol.;* **34**: No. 2, 209-216(Jul 1977).

The requirements for an emergency core cooling system (ECCS) evaluation model that is acceptable for a pressurized water reactor licensing analysis are detailed in Appendix K to 10CFR50. The purpose of these requirements is to ensure that such an analysis will yield a conservative upper bound to the maximum cladding temperature and cladding oxidation that can result from a postulated loss-of-coolant accident (LOCA). By its nature, therefore, this model is inappropriate to indicate the actual anticipated results of a LOCA. Furthermore, a quantitative assessment of the conservatism inherent in the licensing model is unavailable. To produce realistic LOCA results, a calculation was performed at Combustion Engineering (C-E) for the reactor in its System 80/sup TM/ nuclear steam supply system, using a best-judgment ECCS evaluation model. The best-judgment model is a C-E first-generation best-estimate model that uses the basic Appendix K licensing computer programs, but in which the bounding conservatisms required by Appendix K are relaxed for selected parameters and models of primary concern in a LOCA analysis. The important differences between the best-judgment model and the Appendix K licensing model are examined.

56799 **Equation-of-state and nonequilibrium bubble behavior during fast transients.** Steele, W.G.; Okrent, D. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **26**: 168-169(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56800 **Effect of solid fission products and dislocations on swelling and fission gas release in oxides during a fast overpower transient.** Chien, S.H.; Wazzan, A.R.; Okrent, D. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **26**: 169-170(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56801 **Natural convection in porous media with heat generation.** Hardee, H.C.; Nilson, R.H. (Sandia Labs., Albuquerque, NM). *Nucl. Sci. Eng.;* **63**: No. 2, 119-132(Jun 1977).

The heat transfer characteristics of fluid-saturated porous media are investigated for the case of uniform internal heat generation with cooling from above. Analytical models of conduction and single-phase cellular convection show good agreement with previous Rayleigh number correlations and with experimental data obtained by Joule heating of saltwater in a sand bed. An approximate dryout criterion is also derived for two-phase boiling heat transfer in a fixed bed which is neither channeled nor fluidized. Correlation of dryout data using this criterion is encouraging, especially considering the analytical rather than correlational basis of the criterion.

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56867 Modular approach to fault tree and reliability analysis. Olmos, J.; Wolf, L. (Massachusetts Inst. of Tech., Cambridge). *Trans. Am. Nucl. Soc.;* **26**: 395-396(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56868 Experiences with vapor explosions caused by entrapment of water with melts. Froehlich, G.; Mueller, G. (Univ. of Stuttgart). *Trans. Am. Nucl. Soc.;* **26**: 397(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

56869 Preventive fire protection measures in nuclear power plants. Scholz, H. (Technischer Ueberwachungs-Verein Rheinland e.V., Duesseldorf (Germany, F.R.). Arbeitsgemeinschaft Kerntechnik West). *Atomwirtsch., Atomtech.;* **22**: No. 2, 88-89(Feb 1977). (In German).

Short communication only.

56870 How safe. *Mach. Des.;* **49**: No. 1, 20-28(6 Jan 1977).

A study of nuclear reactor core safety commissioned by the AEC concludes that the three potential causes of core accidents--internal plant failure, external forces and sabotage--are all within acceptable limits of probabilistic safety.

56871 Assessment of soil/structure interaction analysis procedures for nuclear power plant structures. Young, G.A. (Agbabian Associates, El Segundo, CA); Wei, B.C. pp 353-362 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

The paper presents an assessment of two state-of-the-art soil/structure interaction analysis procedures that are frequently used to provide seismic analyses of nuclear power plant structures. The advantages of large three-dimensional, elastic, discrete mass models and two-dimensional finite element models are compared. The discrete mass models can provide three-dimensional response capability with economical computer costs but only fair soil/structure interaction representation. The two-dimensional finite element models provide good soil/structure interaction representation, but cannot provide out-of-plane response. Three-dimensional finite element models would provide the most informative and complete analyses. For this model, computer costs would be much greater, but modeling costs would be approximately the same as those required for three-dimensional discrete mass models.

56872 Nonlinear characteristics of liquid sloshing in rigid tanks. Chen, P.Y. (Nuclear Regulatory Commission, Washington, DC). pp

375-387 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

A nonlinear analysis is performed for lateral oscillations of an inviscid, incompressible fluid of arbitrary depth with irrotational flow in a rigid cylindrical tank with an annular sector cross section, which can be regenerated to various sector or various annular tanks. The analysis is carried out for a standing gravity wave motion corresponding to the lowest (first) antisymmetric mode coupled with the other surface waves. The results show that the nonlinear character of the fluid motion can be described by a generalized Duffing-type equation, i.e., the fluid system would behave as either a nonlinear soft spring or as a nonlinear hard spring depending on the system parameters, e.g., the ratio of the fluid height to the tank radius. The theoretical results obtained from the studies compared well with the available theoretical and experimental data reported by many investigators.

56873 Initiation and arrest: two approaches to pressure vessel safety. Brumovsky, M.; Filip, R.; Stepanak, S. (Skoda Works, Plzen, Czech.). pp 695-701 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

The crack-initiation approach and the crack-arrest approach are the two techniques most often used for evaluating the safety of the pressure vessel. The former is based on the methods of Linear Elastic Fracture Mechanics and fracture toughness, while the Fracture Analysis Diagram and the Crack Arrest Temperature underlies the latter. By introducing some formalism and the unified temperature (T/sub R/), the paper tries to formally unify both of these approaches. Experimental data suggest using the Nil Ductility Temperature as a reference temperature for both approaches. Using the theoretical background of Linear Elastic Fracture Mechanics it is possible to construct the Defect Analysis Diagram which summarizes the dependencies of critical sizes of flaws. The dependence on the Crack Arrest Temperature is also included, which seems to be highly advantageous.

56874 Investigation of self-starting of controlled drives in the system of own requirements of nuclear power plants with fast reactors in conditions of emergency cooling-down. Usov, S.V.; Chernovets, A.K.; Shishkov, V.I.; Zonkhoev, G.B. (Leningrad Polytech Inst im. M. I. Kalinin, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 12, 10-18(Dec 1976). (In Russian).

Energy characteristics involved in voltage fluctuations are obtained and the possibility of self-starting of electric drives connected to the circuit of an asynchronous valve cascade from the autonomous power supply networks of the nuclear power plant is evaluated.

56875 Effect of variable thermal conductivity in thermal-hydraulic calculations. Rehbein, D.A.; Carlson, R.W. (Babcock and Wilcox Co, Lynchburg, Va). *Nucl. Technol.;* **31**: No. 3, 348-356(Dec 1976).

Many thermal-hydraulic computer codes employ a fuel rod heat transfer model to couple the fuel rod temperatures with the hydraulic driving forces. Frequently, these models utilize uniform thermal conductivity for the fuel to reduce computer usage and storage. To evaluate the effect of this modeling, the uniform thermal conductivity model in COBRA III was modified to incorporate temperature-dependent thermal conductivity utilizing the complete expansion of the gradient of the heat flux, including the term that represents the gradient of the thermal conductivity. Demonstrative calculations for two transients showed that the peak fuel temperatures are very dependent upon the nonuniformity of the thermal conductivity. It is concluded that a uniform thermal conductivity model is adequate for models that are intended for the analysis of transients where the limiting constraint is the peak cladding temperature, such as the loss-of-coolant-accident.

56876 Molten fuel-coolant interaction during hypothetical accidents in light water reactors. Teschendorff, V.; Wahba, A.B. (Tech Univ Muenchen, Garching, Ger.). *Nucl. Technol.;* **31**: No. 3, 297-305(Dec 1976).

Thermal interaction between molten fuel and coolant plays an important role in nuclear reactor safety. A molten fuel-coolant interaction model for water was developed and tested by calculating the propagation of pressure waves observed in some of the in-pile SPERT experiments. Both interaction and acceleration zones are modeled by the same set of equations that accounts for compressibility and inertia of the coolant. Calculations with this one-dimensional model BLAFCI show that particle size distribution and fragmentation time are the most sensitive parameters. Calculated peak pressures and some of the pressure time curves up to 10 msec agree well with the experimental data.

56877 (NP-tr—1977) Theoretical fundamentals for the SAFTL and CRESS program system to calculate system reliability. Birkhofer, A. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Garching/Muenchen (Germany, F.R.)). Sep 1976. Translation by T.W. Appich Jr. of MRR—164. 39p. Regulatory Commission, Washington, DC.

The aim of this report is a brief presentation of the methods used in the computer codes SAFTL and CRESS. Apart from the specific procedures of these codes, the background necessary for understanding them is described.

56878 (EURFNR—1370) Evaporation kinetics of oxide fuels and their effect on the actinide redistribution in reactor fuel pins and on fuel vapor pressure under accident conditions. Breitung, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Jun 1976. Translation of KFK—2240. 164p. Dep. NTIS, PC A08/MF A01.

Work performed under United States—Euratom Fast Reactor Exchange Program.

This work deals with the evaporation kinetics of uranium oxide and uranium-plutonium mixed oxide. Since these oxides evaporate incongruently, the composition of an oxide specimen is generally subjected to changes during evaporation. Mathematical models were developed for free evaporation and for evaporation in closed cavities, which allow to calculate location and time dependent redistribution in evaporating specimens. The models are applicable to any multi-component system, showing incongruent evaporation. The calculations made with respect to core accident conditions have shown that the fuel surface composition changes rapidly in open-evaporation, when the fuel evaporates freely or into major cavities. The changes of surface composition result in a change of the vapor pressure over the oxide. Calculations on pore migration have shown that a pore migrating as a result of evaporation and condensation of (U, Pu) mixed oxide will transport plutonium (or uranium) to the center of the fuel pin. Starting from this single effect, the total redistribution effect caused in a fuel pin by migrating pores was calculated. It was shown in an out-of-pile experiment that the migration of pores in the temperature gradient is an effective mechanism for (U, Pu) redistribution. This was also confirmed by post-irradiation investigations of pins of an FR2 irradiation experiment. Superposition of the redistribution effect of pore migration on that of thermodiffusion yielded good agreement between measured and calculated radial (U, Pu) distributions for three fuel pins having initial stoichiometries of 1.90, 1.95 and 2.003, respectively.

56879 Systems engineering applications for safety models in nuclear reactors. Gheorghe, Ad.V. (Polytech of Bucharest, Rom). *Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.;* **21**: No. 4, 603-615(1976).

In this paper, results of previous methodology applied to large scale engineering systems are presented. The class of light water-cooled reactors and especially the BWR are considered. First, a general description of a BWR system is given with particular reference to safety analysis for a nuclear power station equipped with such a reactor.

56880 Aerosols in nuclear engineering. Schikarski, W. (Kernforschungszentr, Karlsruhe, Ger.). *Dechema Monogr.;* **80**: No. 1639-1669, 595-621(1976). (In German).

Most energy transformation processes are accompanied by the production and emission of aerosols. During normal operation of nuclear power plants the aerosol emission into the environment is relatively small. For the case of LMFBR's extensive investigations have been carried out on the behavior of nuclear aerosols. Experimental and theoretical results are reported which allow the prediction of aerosol concentrations in closed vessels for a long time period. Extensive experimental data are included. 15 refs.

56881 Assessment of emergency core cooling system effectiveness for light water nuclear power reactors. Finlayson, F.C. Pasadena, CA; California Institute of Technology (1975). vp.

The results of the hearings conducted by AEC in 1971-1973 are independently reviewed and evaluated. The critical technical parameters influencing ECCS performance are identified. Of fifteen parameters cited by the Advisory Committee on Reactor Safety in the hearings as being of unproved conservation, essentially all are reviewed in detail, including the initial stored fuel energy, fuel rod gas gap conductance, fluid flow rates through broken pipes, metal-water reaction energy release and fuel rod embrittlement, reflood/core-spray heat transfer, and reflooding rates, as well as the adequacy of ECCS analytical models and numerical methods. The relative influence of uncertainties in the performance criteria is assessed. Alternative responses to resolution of the ECCS problem are analyzed. The importance of the core reflooding rate in resolving the technical issues of the problem is emphasized. Recommendations are made for improvements in criteria conservatism, especially in the establishment of minimum reflood heat transfer rates (or alternatively, reflooding rates). Several new and/or accelerated research programs and additional large scale testing programs are made for areas in which design improvements would help to achieve greater ECCS reliability. 67 refs.

56882 (ERDA-tr—273) **Peaceful utilization of nuclear energy: effects on the policy of security in the Federal Republic.** Gottstein, K. [nd]. Translation of German report. 9p. Dep. NTIS, PC A02/MF A01.

The potential effect of the presence of nuclear reactors on the losses occuring from a limited war are discussed. The effects of the presence of nuclear reactors on national defense are examined.

ENERGY STORAGE

REFER ALSO TO CITATION(S) 56231, 57741

56883 (AED-CONF—76-377-002) **Energy storage during orbital and interplanetary missions.** Igenbergs, E. (Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl fuer Raumfahrttechnik). Sep 1976. 16p. (In German). (CONF-7609147—2). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Annual meeting of the Deutsche Gesellschaft fuer Luft- und Raumfahrt e.V.; Munich, German, Federal Republic of (F.R. Germany) (14 Sep 1976).

A new method of energy storage during an interplanetary transfer trajectory can lead to an increase in the payload. The optimal distribution of energy supply, energy conversion, and fuel was ascertained for an orbital mission. When combining an interplanetary mission with an orbital one, the payload can contribute to its transport when the energy is stored in the last stage.

MAGNETIC

REFER ALSO TO CITATION(S) 57742

COMPRESSED GAS

56884 (CONS/NSF/42—1) **Preliminary feasibility evalution of compressed air storage power systems. Volume II. Appendices, period June 1975—December 1976.** (United Technologies Research Center, East Hartford, Conn. (USA)). Dec 1976. vp. Dep. NTIS, PC A11/MF A01.

Interest in compressed air storage has been developing in Sweden, Finland, Denmark, England, and France, as well as the United States. One commercial unit is under construction in Huntorf, West Germany. Compressed air for peak power can be stored either in natural or man-made caverns. Only new excavations in hard rock down to depths of about 2500 feet are considered in this report. In 1974, conditions for underground storage were discussed in a Geological Survey of Potential Cavern Areas in New England, referred to as the CAINE report. In this survey of the northeast region, the rest of the corridor between Washington and Boston has been added. The rock formations in the entire area of about 45,000 square miles are evaluated. The physical properties of rocks and criteria for their evaluation in underground openings are discussed. Methods of rock excavation and the basis for selecting areas are considered. Information on bedrock units along the corridor is reviewed. A list of favorable rock formations is included.

PUMPED HYDRO

REFER ALSO TO CITATION(S) 56083

56885 **Pumped storage hydroelectric plants.** Penai, S. (Ente Naz per l'Energ Elettr, Italy). *Energ. Elettr.;* **53**: No. 10, 521-532(Oct 1976). (In Italian).

The paper briefly describes the characteristics of the Italian electric power production and mentions the forecasts for the near future. Daily load diagrams of ENEL grid are illustrated and their similarity in time is shown. These diagrams are utilized to determine the functional characteristics of the power plants which are to be entered in programs to meet the future demand of electric power. The computation of pumped-storage hydroelectric plants economic convenience, taken as determination of allowable cost limit, is illustrated evaluating the main parameters with reference to the present situation and extending the study to the near future, when the production of electric power will mainly depend on advanced nuclear power plants. Lastly, the general criteria that dictate the sizing of major structures are mentioned, such as: tunnels, steel penstocks, machinery, with particular reference to the problems associated with the installation of large hydraulic machines. Summarized also are important data relating to major power plants either built or being built in Italy.

FLYWHEELS

REFER ALSO TO CITATION(S) 57071, 57308

56886 (UCRL—50033-77-1) **Fiber-composite flywheel program. Quarterly progress report, January—March 1977.** Rinde, J.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 May 1977. Contract W-7405-ENG-48. 17p. Dep. NTIS, PC A02/MF A01.

Progress on the design and performance of fiber-composite flywheels for energy storage is reported. Topics covered include composite flywheel design study, composite properties, rubberized epoxy resin systems, and matrix resins for fiber composites. (TFD)

THERMAL

REFER ALSO TO CITATION(S) 56091, 56106, 56151, 56152, 56153, 56154, 56155, 56156, 56157, 56158, 56159, 56160, 56161, 56162, 56163, 56164, 56165, 56166, 56167, 56168, 57002

56887 **Proceedings of a NATO science committee conference on thermal energy storage (TES).** *Energy (Oxford);* **2**: No. 1, 53-101(Mar 1977).

The journal includes an introductory paper and reports by four Working Groups of the Conference. The introductory paper is a tutorial review of the relevant thermodynamics. The author suggests, that since energy is always conserved, and since the energy being considered here is free energy, available energy, or latent work, the word exergy, recently proposed, could be substituted. Working Group A reports on High Temperature Thermal Energy Storage (TES) which comprises the range of 120-1250 C. Sensible heat storage in solids and liquids, latent heat storage and chemical energy storage are considered. Working Group B reports on Low Temperature TES, defined to mean storage of heat that enters and leaves the reservoir at temperatures below 120 C. The storage of cold (below-ambient) is also considered in some cases. Working Group C reports on Heat Transfer and Thermal Energy Transport, considering geostorage, solid material storage, liquid storage, phase-change systems for low and high temperature applications, fluidized-bed storage, condensation and boiling, chemical storage, liquid metal storage, energy losses from TES, and transport or energy from store to use. Working Group C reports on the Impact of TES on Energy Structures, which are defined as residential and commercial, industrial, urban, thermal energy transport including transportation, and electric utilities.

CHEMICAL

REFER ALSO TO CITATION(S) 56155

BATTERIES

REFER ALSO TO CITATION(S) 57834

56888 (N—77—16437) **Secondary aerospace batteries and battery materials: a bibliography, 1969 — 1974.** Mcdermott, P.; Halpert, G.; Ekpanyaskun, S.; Nche, P. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Jul 1976. 161p. (NASA-SP—7044). NTIS PC A08.

This annotated bibliography on the subject of secondary aerospace battery materials and related physical and electrochemical processes was compiled from references to journal articles published between 1969 and 1974. A total of 332 citations are arranged in chronological order under journal titles. Indices by system and component, techniques and processes, and author are included.

56889 **Battery Council International convention: 1975.** Chicago; Battery Council International (1975). 180p. (CONF-7504129—).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975).

Separate abstracts were prepared for seventeen of the reports contained in this volume. (RWR)

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 56899

56890 **Batteries for the '80s: the materials of energy storage.** *Met. Mater.;* 36-38(Dec 1976).

A growing interest in storage batteries has been sparked by two recent developments--the need to smooth the loads on generat-

ing stations, and the demand for pollution-free, battery-driven road vehicles. The article outlines the construction and performance of existing and novel secondary battery schemes with special reference to the materials aspect.

56891 Recovery of lead from battery scrap. Wilson, D.A. (to Dept. of the Interior). US Patent 3,940,265. 24 Feb 1976. Filed date 25 Jun 1975. 4p.

Lead is recovered from battery scrap by means of a process comprising reacting the scrap with a slurry of calcium hydroxide to form a product comprising PbO and $CaSO_4 2H_2O$, filtering and drying the reaction product, and reacting the product with a mixture of carbon and a KCl--NaCl flux at elevated temperature to flux the calcium sulfate and reduce the lead oxide to metallic lead.

56892 Replacement battery. Industry forecast 1975—1979, a report by the BCI Statistical Committee. pp 34-40 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

The market for replacement lead—acid batteries of the automotive type is discussed. A model which attempts to forecast demands for replacement batteries is explained. (RWR) 16 figures.

56893 Sodium—sulfur battery. Weiner, S.A. (Ford Motor Co., Detroit). pp 54-62 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

Possible application of the sodium—sulfur battery to load leveling and electric propulsion is explained. Deficiencies of these batteries (and others) are discussed. The electrochemistry of the sodium—sulfur battery is considered; the importance of the ceramic is emphasized. A fairly large amount of research and development work remains to be done. 9 figures, 4 tables. (RWR)

56894 Gould Dynamic battery. Sabatino, A. (Gould, Inc., St. Paul). pp 100-104 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

In this type of dry charge battery the plates and separators are moist and contain 20 to 40% of the acid which normally would be present in a wet battery. The seal plugs allow hydrogen to escape but prevent entry of air. These batteries have high initial activation cold cranking capacity and excellent capacity retention. Fabrication of this type of battery, compatible with the conventional wet processing, is explained. (RWR) 9 figures.

56895 ILZRO health studies. Cole, J.F. pp 114-119 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

The research effort of the International Lead Zinc Research Organization, Inc. encompasses the effects of lead emissions to the atmosphere on the general public, as well as studies in the water pollution and occupational health fields. The study discussed deals with the effects of lead exposure on children living in the area of a lead smelter. The ILZRO concluded that comprehensive testing failed to reveal any detrimental effects of lead on the health or well-being of the children. [(RWR) 12 figures.

56896 Environmental control problems. Bitler, J. (General Battery Corp., Reading, PA). pp 120-123 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

Regulatory problems as related to battery production are discussed. The first part of the report considers lead discharged into water. Clarification of waste material by treatment with lime also results in problems. Other ways of dealing with sludge are related. Antimony is another waste which must be handled. The second part of the paper deals with pollution of air by lead. (RWR)

PERFORMANCE AND TESTING

56897 (AED-CONF—76-203-006) **Electrochemical power sources in ocean engineering.** Koethe, H.K. (Varta Batterie A.G., Kelkheim (Germany, F.R.). Forschungs- und Entwicklungszentrum). 1976. 14p. (In German). (CONF-760690—1). Dep. NTIS (US Sales Only) $3.50.

From 3. international conference and exhibition) research-technology-economics (Interocean 76); Duesseldorf, German, Federal Republic of (F.R. Germany) (15 Jun 1976).

Ocean engineering employs nearly all types of primary and secondary batteries. This wide usage obviously is due to their basic simplicity, compatibility with almost all environmental conditions including high pressure, high reliability, and commercial availability. Fuel cells cannot yet be delivered from stock. However, this lack of availability is not due to poor performance of the prototypes but to the still very limited market. Hence, for the next several years the battery solution will be prevailing, even at high powers. For some missions of long endurance, the combination of batteries with generators using the primary energy of wind, waves, or the sun can be an excellent solution. Almost each battery experiences self-discharge, even when no load is connected to its terminals. Hence, primary reserve electrolyte batteries have been constructed which experience no aging before activation. All primary systems can be operated under sealed conditions. Secondary batteries basically can be divided into vented types and sealed types. Both of them can be operated in the depth of the sea for a prolonged time. Vented batteries for this purpose must be equipped with pressure equalizing systems. Sealed types can be put into pressure hulls, or, if convenient, also be potted into resin. In each of these applications special information for battery operation provided by the supplier. 10 figures, 6 tables.

56898 (N—77-10661) **Testing of NiCd cells over geostationary orbit type cycling period.** (Compagnia Generale di Elettricita S.p.A., Milan (Italy). Div. Elettronica). 1975. Contract ESTEC-1185/70-HP. 65p. (ESA-CR(P)—832). NTIS, PC A04/MF A01.

Geostationary orbit type cycling was carried out in order to permit NiCd cell lifetime to be assessed as a function of temperature, charge rate and factor, and depth of discharge in unlimited charge mode operation. A second objective was to collect information on correlation between cell operation in geostationary orbit type cycling and operation under fixed depth of discharge cycling conditions. Tests performed on 180 NiCd cells are described and data collected during 2 years' cycling are presented.

56899 Researchers study new batteries. *Electr. Veh. Batteries;* **62:** No. 4, 21(Dec 1976).

A new type of batterywhich, it is believed, could store up to 20 times more energy for its size and weight than the present lead—acid kind is being investigated by a U.S. Government sponsored research team at the Energy Research and Development Administration's Lawrence Livermore Laboratory in California. Concurrently, tests with nickel—zinc batteries are being undertaken by the National Aeronautics and Space Administration's Lewis Research Center in Cleveland, Ohio. As a part of their studies, the Lawrence Livermore researchers are exploring similar batteries based on reactive but potentially less expensive metals such as calcium, magnesium, aluminum, sodium and their alloys. These batteries are of the primary type; they are recharged by replacing the lithium rather than by being recharged electrically. A sample nickel—zinc battery at NASA Center makes use of cells produced by two industrial contractors, a feature of which is an inorganic separator adapted from space battery technology. The battery has been installed in an electric utility van, using a battery weight equivalent to the conventional lead—acid type. Tests have shown that with the nickel—zinc battery it was possible to make almost twice as many stop—start driving cycles per charge as with the lead—acid battery (190 to 99). Driven at a constant speed of 20 mph, the van ran for 54.9 miles with the nickel—zinc battery and only 29.4 miles with the lead—acid before recharging was necessary.

56900 Actual service life and bench cycle life of lead—acid battery for electric vehicle use. Kamada, K.; Okazaki, I.; Takagaki, T. (Japan Storage Battery Co., Ltd., Tokyo). pp 4-26 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

A battery bench test, which would give a better representation of actual service conditions, was devised. The results of the test are compared with results obtained in actual use. 9 figures, 4 tables.

MATERIALS, COMPONENTS, AND AUXILIARIES

56901 Lead storage battery electrode and method. Sundberg, E.G. (to Aktiebolaget Tudor). US Patent 4,025,701. 24 May 1977. Priority date 18 Apr 1972, Sweden. 4p.

A tube plate-type electrode for a storage battery is described. The metal rod of the tube is held centrally in a surrounding sheath by spacing fins. The surface of the spacing fins is coated with a lacquer to reduce the peak effect caused by high current density to prolong the life of the tube sheath. 4 figures.

56902 (SAND—77-6009) **Lithium ion conductive electrolyte composition.** Ikeda, H.; Narukawa, S. May 1977. Translation by H.

Kubota of Japanese Patent 1974-81899. 7p. Dep. NTIS, PC A02/MF A01.

A solid electrolyte for a lithium battery is disclosed. It is a three-component system with the general formula Li_2SO_4—LiOH—LiI. This substance has a low conductivity at low temperatures, but the conductivity increases sharply above 170°C and assumes the high value of 5 x 10^{-2} (OMEGA cm)$^{-1}$ at 200°C. Appropriate compositions range as follows: 30 to 45 mol percent Li_2SO_4, 30 to 45 mol percent LiOH, and 10 to 40 mol percent LiI. Fabrication of this material and the design and performance of a battery in which it may typically be used as electrolyte are explained. 3 figures. (RWR)

56903 Electrode assembly for bipolar battery. Fritts, D.H. (to Dept. of the Air Force). US Patent Application 642,524. 19 Dec 1975. 10p.

A bipolar electrode having, between active materials, a heat sink fabricated from a porous electrical and heat conductive material, such as sintered silver, is described. The porous material is impregnated with a phase-change heat-absorbent material having a high heat of fusion, such as beeswax. The electrode has a very large thermal capacity for a high-discharge-current-density battery.

56904 Current trends in battery separators. Palmer, N.I. (W.R. Grace and Co., Cambridge, MA). pp 105-110 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

The requirements which must be met by the separators in today's batteries and the materials being developed to meet these requirements are outlined. (RWR) 6 figures.

56905 Maintenance free batteries: evolution or revolution. Young, J.A. Jr. pp 127-134 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

The maintenance-free battery is regarded as both the product of an orderly evolutionary trend and the spawning ground for revolutionary developments in battery manufacturing processes. "Maintenance-free" is an evolutionary concept by virtue of the reduction of Sb in the grid alloy, introduction of non-antimonial Pb—Ca—Sn alloys, and improvements in conventional grid casting techniques. This yields either a low-maintenance or a maintenance-free product of relatively conventional shape and design. The use of non-antimonial alloys--specifically Pb—Ca—Sn alloys--has made possible the consideration of sheet lead as a grid material and has opened the possibilities of revolutionary high-speed manufacturing processes, battery designs, and performance characteristics. (RWR) 14 figures.

56906 Tin and bismuth in lead—calcium alloy. Myers, M. (American Smelting and Refining Co., New York). pp 135-139 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

Some metallurgical aspects of the Pb—Ca—Sn—Bi alloys system are discussed. Specifically, metallurgical aspects of Bi concentrations of up to 0.1% and tin up to 1% were examined. It is found that there is no need for Sn levels as high as 0.5 or 1%; Pb—0.06Ca alloy presents improvement in casting fluidity with the addition of as little as 0.1% Sn. It is suggested that improved alloys would result if tin concentrations were lowered and bismuth concentrations were raised. 7 figures. (RWR)

56907 Lead calcium grid casting. Wirtz, J.W. (Wirtz Manufacturing Co., Port Huron, MI). pp 140-141 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

The casting of lead—calcium alloys into battery grids is briefly discussed. The alloys involved are lead with about 0.08% Ca and from 0.25 to 1% Sn. Hardness, oxidation rates, and melting and solidification temperatures are addressed. Casting machines have been developed which permit the fabrication of 60 grids in a minute. (RWR)

APPLICATIONS

REFER ALSO TO CITATION(S) 57068, 57069

56908 Batteries for mail vans. Christianson, C.C. (Gould Corp., St. Paul). pp 46-48, 52-53 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

An electric vehicle designed for the U.S. Postal Service is described. The propulsion system components of the postal van are discussed in some detail. The battery is a 27-cell, 54-V battery weighing about 1300 pounds and delivering 330 Ah. A dc to dc converter converts 54 V to 12 V for accessories. Regenerative braking is utilized when stopping from more than 15 mph. Charging and performance data are summarized. (RWR) 5 figures.

ENERGY MANAGEMENT AND POLICY

56909 (PB—264200) **A directory of computer software applications: energy. Report for 1974—1976.** Grooms, D.W. (National Technical Information Service, Springfield, Va. (USA)). Apr 1977. 75p. NTIS PC E10/MF E10.

The computer programs or the computer program documentation cited in this directory have been developed for a variety of applications in the field of energy. The cited computer software includes applications in solar energy, petroleum resources, batteries, electrohydrodynamic generators, magnetohydrodynamic generators, natural gas, nuclear fission, nuclear fusion, hydroelectric power production, and geothermal energy. The computer software cited has been used for simulation and modeling, calculations of future energy requirements, calculations of energy conservation measures, and computations of economic considerations of energy systems.

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 56909, 56936, 56984, 57012

56910 Economic benefits of district heating. Wallington, J.W. *Chart. Mech. Eng.;* **24**: No. 3, 56-59(Mar 1977).

The economic advantages derived from three main factors: 1. The use of a low grade fuel in substitution for a higher grade. For example, a low grade coal or heavy fuel oil in place of anthracite, light fuel oil or natural gas. This is made possible by the more sophisticated handling plant and controls which can be justified on high rate boilers. Even domestic refuse can be used as a fuel for this purpose. 2. A higher 'season-through' efficiency can be obtained in the operation of a well designed, well instrumented and well operated plant, as compared to domestic heating appliances. It is quite possible to obtain 78-80 per cent efficiency on coal fired or heavy fuel oil fired boilers whereas the normal efficiency of a domestic central heating boiler operating on coal, light oil or gas is unlikely to rise above 60 per cent when considered over the entire heating season. In addition, as the heating load falls off in the autumn and spring a central boiler plant can take advantage of the diversities of load which occur. 3. Perhaps the biggest economy in the use of fuel is achieved when heat and electricity are generated in a combined process. 11 refs.

56911 District heating in the Czechoslovakian energy balance. Peer, V.A. (Dtsch BP, Hamburg, Ger). *Fernwaerme Int.;* **6**: No. 1, 10-12(Mar 1977). (In German).

The Energy Research Institute in Prague, under the auspices of the Ministry of Fuel and Energy has made a study of possible substitutes in the energy balance of Czechoslovakia up to 1990. Special attention was paid to heat generation and distribution. This article gives a summary of the energy balance study. It is concluded that Czechoslovakia does not possess adequate indigenous energy resources. By 1990, it will have to import about 25 Mt of crude oil and 15 M cubic meters^3 of natural gas. The output of solid fuels can be increased but slightly and by 1990 about 5.2 Mt of hard coal equivalent of solid fuels will have to be imported. District heating development is discussed.

56912 District heating pricing as an inducement for energy saving. Luther, G. (Univ des Saarlandes, Saarbruecken, Ger). *Brennst.-Waerme-Kraft;* **29**: No. 3, 89-90(Mar 1977). (In German).

The basic-rate tariff for district heating that is customary today includes hardly any inducement for the consumer to save energy, due to the high proportion of the fixed costs. With known climate data, the maximum rate required by a customer can be calculated from the amount of heat consumed over a heating period. It can be shown that a formal unit-price tariff can be compatible with the requirement to cover both thehe costs of the units supplied as well as the costs of making available the performance required. This

tariff provides, however, a much greater inducement to save energy and to install a better heat insulation.

56913 Principles of design of schemes of district heating systems in cities, their automation, and installation of remote control facilities. Gromov, N.K. (Acad of Urban Econ im. K.D. Pamfilova, USSR). *Teploenergetika (Moscow);* No. 11, 28-34(Nov 1976). (In Russian).

Modern schemes of district heating systems in cities are described, and problems of their controllability, reliability, and efficiency are analyzed. A discussion concerning the problems raised is appended.

56914 Problems in heating economics and district heating. Strempel, E. *Energie;* **28**: No. 11, 312-317(Nov 1976). (In German).

Design criteria for district heating systems in relation to energy sources, climatic conditions, and type of cities are outlined. Methods for evaluation of total power for heating in an average cold winter are presented. 6 refs.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 56741, 56743, 56910, 56914, 56932, 56933, 56936, 56947, 56954, 56956, 56959, 56963, 56965, 56966, 56968, 56970, 56971, 56986, 57013

56915 (BNL—50634) **Land use—energy simulation model: a computer-based model for exploring land use and energy relationships.** Carroll, T.O.; Kydes, A.S.; Sanborn, J. (Brookhaven National Lab., Upton, N.Y. (USA)). Jun 1977. Contract EY-76-C-02-0016. 69p. Dep. NTIS, PC A04/MF A01.

There is no doubt that major conservation of future regional energy expenditures can be achieved through the propitious allocation and configuring of land-use activities. The task of searching for and selecting strategies and measures which will bring about energy conservation vis-a-vis land use becomes that of understanding and defining relationships between sets of possible land use activities in a given region and the resultant energy end use demand. The outcome of the search is the determination of the relative impact of the strategies and measures upon both the regional and national energy system. The Land Use-Energy Simulation Model with integrated capability for generating energy demand is an extension of the classic Lowry model. Such a model framework captures two essential features of the land use-energy utilization interaction; first, the spatial location of land use activity is implicit, and second, transportation energy demand is determined as an integral part of the spatial configuration. The model is divided both conceptually and computationally into three parts; the land use model, a submodel for transportation which provides the work and shop trip distributions for spatial allocation of activities within the land use submodel, and an energy submodel which determines the energy demand from the land use configuration. Two specific types of applications of thecomputer model are described. The model was utilized to assess the energy demand of the Long Island region in New York. Second, the model was applied to study the generic relationships between energy utilization and urban form.

56916 (BNWL—2298) **Hanford reservation area worker census: a research report for the Rockwell Hanford Operations.** Yandon, K.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jul 1977. Contract EY-76-C-06-1830. 15p. Dep. NTIS, PC A02/MF A01.

Highlights of the worker census show: nearly 15,000 workers are in or immediately adjacent to the area; there are 21 employers; measured from the Purex plant, 80% of the total work force is located east-southeast and southeast; again centered at Purex Plant, 7% of the work force is within 2 miles, 20% within 10 miles, and 55% within 12 miles; the largest single concentration of Hanford Area workers, 38%, is found 17 to 19 miles from the Purex Plant center; informed sources estimate that another 10% could be added to the work force total traveling in the Area on Hanford-related business; worker counts are only correct for a specific time (their fluctuations depend on construction schedules); and construction worker counts can vary from 600 to 3500 over a project time period. Distribution of workers by radii and compass direction is explained. (MCW)

56917 (PB—265113) **Accommodation in the international capital markets and the recycling of oil funds. Working paper.** Agmon, T.; Lessard, D.R.; Paddock, J.L. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Apr 1976. 28p. (MIT/EL—76/010WP). NTIS PC A03/MF A01.

Report on 'World Oil Project'.

In this study of the international oil market, the relationship between primary and secondary recycling in the capital markets as well as the accommodating movements in the goods market are discussed in a context of an adjustment process. It is argued that time for adjustment is necessary for both oil-importing and oil-exporting countries. An international capital market with international financial intermediation is an essential part of a smooth adjustment process. The observed quantities of traded oil, as well as the estimated short- and long-term elasticities of demand for oil, reflect the effectiveness of the international capital market in supplying adjustment services. The nature of the adjustment process as well as the function of the capital markets in this respect are presented in Section 2. Section 3 presents a simple model to indicate the contribution of effective multilateral trade in capital assets on the flow and the prices of oil. The available empirical evidence on recycling and the nature of the adjustment process are described and analyzed in Section 4.

56918 (PB—265295) **Job creation through energy conservation: a solution to a crisis.** (Action Associates, Inc., Bridgeport, Conn. (USA)). 1 Mar 1977. Contract DL-B7B-5539. 125p. NTIS PC A06/MF A01.

The report is a proposal for a project that calls for the planning and creation of a prototype organization which will be the initial effort in a large-scale national program designed to effect a substantial reduction in energy consumption through a massive program of weatherization and other energy-conservation measures. This will be done by the development of alternate-energy businesses emphasizing creation of jobs for the poor and near-poor and by making energy conservation affordable for these and other income groups.

56919 Input-output analysis and energy intensities: a comparison of some methodologies. Proops, J.L.R. (Univ of Keele, Staffs, Engl). *Appl. Math. Model.;* **1**: No. 4, 181-186(Mar 1977).

Energy analysis is concerned in discovering how energy is used in economics. A particular facet of the study is the devising of means or 'charging' the goods produced by an economy with the energy 'used' by that economy. That is, how much energy has been used, through the workings of that economy, in the production of a unit of a certain good. The goods produced may be measured in physical units (tons) or monetary units. In particular, the energy used per monetary unit of goods produced is referred to as the 'energy intensity' of that good. Various measures for the energy intensities of produced goods have been suggested, all of which require that the economy be represented as composed of several interrelated producing sectors, and one or more consuming sectors. These interrelationships are most easily represented by input-output tables. Such input-output tables are used here to describe economies in two ways. First, in terms of the normal table, in monetary units. Or second, as a corresponding table of energy dissipation, expressed in physical units. The normal input-output table is an accounting device, and requires that the sum of the outputs from a productive sector be equal to the sum of the inputs to that productive sector. 9 refs.

56920 Mineral industry in the Canadian economy: review and outlook. Kowalski, G. (Can Dep of Energy, Mines and Resour). *Can. Min. J.;* **98**: No. 2, 9-20(Feb 1977).

Overall demand for Canadian nonfuel minerals in 1976 was up from 1975. Market conditions improved for iron ore, molybdenum, asbestos and flat-rolled steel products, but continued to be weak for many nonferrous metals, structural steel products and construction materials. Some price increases announced by nickel, copper and zinc producers had to be rolled back, or circumvented by offering price protection on future deliveries, when actual demand fell short of expected demand in mid-1976. The decline in the price of gold during the year raised concerns about the future of gold mining in Canada.

56921 Determination of the annual economic effect of automation of control of an electric utility enterprise. Korotkevich, M.A. (B SSR Polytech Inst). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 10, 121-124(Oct 1976). (In Russian).

It is shown that the existing method of determination of the rated percentage profit of an electric utility is based on the utilization of stable norms of deductions for the economic stimulation funds and does not depend on the total production values of the utility. For this reason, the annual savings due to the introduction of automatic control in the utility, which does not directly realize electric power, ought to be determined without taking into account the rated percentage profit.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 55656, 55792, 56741, 56957, 56975

56922 (PB—264529) **Environmental research outlook for FY 1977 through FY 1981: report to Congress.** (Environmental Protection Agency, Washington, D.C. (USA). Office of Research and Development). Feb 1977. 196p. (EPA—600/9-77/002). NTIS PC A09/MF A01.

See also report dated Feb 1976, PB—250523.

This is the second of a series of annual reports to Congress presenting a five-year projection of environmental research activities to be conducted by the U.S. Environmental Protection Agency. The general role of environmental research is discussed in the context of the Agency's regulatory and assistance functions and the National goal of protecting and enhancing the environment. Anticipated research over the next five years is discussed for each of the fourteen subprograms, as well as for six 'current interest modules' which cut across several of the subprograms. The dominant programs in the forecast period are health effects studies and energy-related comprehensive environmental research. Impacts of level and increasing budgets on scheduling of program outputs are discussed.

56923 (PB—265398) **Accidents and unscheduled events associated with non-nuclear energy resources and technology. Final report.** Bliss, C.; Clifford, P.; Goldgraben, G.; Graf-Webster, E.; Krickenberger, K. (Mitre Corp., McLean, Va. (USA). METREK Div.). Feb 1977. Contract EPA-68-01-3188. 293p. (M—76-68). NTIS PC A13/MF A01.

Accidents and unscheduled events associated with non-nuclear energy resources and technology are identified for each step in the energy cycle. Both natural and anthropogenic causes of accidents or unscheduled events are considered. Data concerning these accidents are summarized. Estimates of frequency and severity are presented for all accidents. The energy systems discussed are coal, oil, natural gas, LNG, hydroelectric, geothermal, oil shale, and solar energy.

56924 **Environmental implications of nontechnological methods to conserve energy.** Gibbons, J.H. (Univ of Tenn, Knoxville). *Energy Commun.;* 3: No. 2, 171-186(1977).

A review is presented of the environmental implications of energy policy developments over the last several years. Future policy options are then considered: roll-back prices; assuring a platform price for energy; deregulate oil and gas prices; public policies to induce shifts to increase efficiency of use; labeling and education; minimum performance criteria through regulation and incentives; allocation and rationing; relax and alter environmental and other regulations.

ENERGY RESOURCES

REFER ALSO TO CITATION(S) 55739, 55760, 55853, 56936, 56956, 56959, 57088, 57834

56925 **Recycling waste.** Smith, P.I.S. Broseley, Eng.; Scientific Publications (G.B.) Ltd. (1976). 187p. International Inc., Flushing, NY.

It is being realized that if environmental quality is to be improved the amount of waste generated by man has to be substantially reduced. There are two ways this can be achieved. First, by conserving materials and energy, and sacrificing economic growth, a solution that is completely unacceptable because it would mean some form of rationing, mass unemployment, and collapse of society as it is known. The second way to reduce the volume of waste is by planned recycling, re-use, and recovery. Already the reclamation industry recovers, processes, and turns back for re-use many products used by industry and thereby reduces the UK's import bill for raw materials. In the book, the author sets out the various ways materials may be recovered from industrial and municipal wastes. The broad technology of waste management is covered and attention is focused on man's new resources lying buried in the mountains of industrial wastes, the emissions from stocks, the effluents and sludges that turn rivers into open sewers, and municipal dumps in seventeen chapters. The final chapter lists terms and concepts used in waste technology, organizations concerned with waste management, and sources of information about recycling waste. (MCW)

56926 (PB—264457) **Biological productivity of renewable resources used as industrial materials.** Bethel, J.S. (National Research Council, Washington, D.C. (USA). Committee on Renewable Resources for Industrial Materials). 1976. Contract NSF-STP75-01069. 112p. NTIS PC A06/MF A01.

See also report dated Sep 1976, PB—257357.

The report estimates the biological productivity of industrial renewable resources in terms of current yields, existing land bases, and increments to these bases that may reasonably be forecast by 1985 and 2000. The forecast divides naturally into two parts: the silvicultural product of wood, and products for industry from agriculture consisting chiefly of vegetable fibers, oil seeds, wool, animal fats, tallows, and hides. Wood is not only by far the most important renewable resource used for industrial materials, but also one whose production can be greatly increased if needed. Agricultural products include cotton and other vegetable fibers. Furthermore, there is little reason to believe that market demand will strain biological potential by 1985 or 2000. Under these conditions, long-term estimates of productivity become a mere exercise in imagination. Consideration is made of the energy requirements and environmental impacts associated with the implementation of the recommendations on these renewable resources.

56927 (PB—264494) **Reference materials system: a source for renewable materials assessment.** Bethel, J.S. (National Research Council, Washington, D.C. (USA). Committee on Renewable Resources for Industrial Materials). 1976. 86p. NTIS PC A05/MF A01.

See also report dated Sep 1976, PB—257357.

Potential problems from changes in patterns of materials supply or use are causing concern: the current emphasis is on mineral or nonrenewable resources. The Science and Technology Policy Office (STPO), reexamined the role of renewable resources, as the other major component of natural resources, in helping to better meet needs for materials in the future. Important factors to be taken into account in assessing the desirable balance between these different classes of resources for materials are (1) the increasing variety of technological options available for choice of material for a required performance in a given application, and (2) the increasing concern to minimize both consumption of energy and environmental impact. Strong specialization exists in forest sciences and wood products on the one hand, and agricultural sciences and associated natural materials (such as fibers and leathers) on the other. A broader view is required of the science and technology of natural products and, correspondingly, more integrated statistical information on resources, and on materials flows and use (including aspects associated with energy and the environment). The above considerations led to this analysis of renewable materials in the United States economy as a basis for identifying both the optimum use of such resources and the role of science and technology in helping overcome barriers to their use.

56928 (PB—264561) **Fibers as renewable resources for industrial materials.** Bethel, J.S. (National Research Council, Washington, D.C. (USA). Committee on Renewable Resources for Industrial Materials). 1976. Contract NSF-STP75-01069. 271p. NTIS PC A12/MF A01.

See also PB—257357.

Contents include: the pulp, paper and paperboard industry (assessment of the industry, some factors affecting the industry, enhancement of availability and utility of materials with reduction in costs, enhanced role of renewable fiber resources--an overview of product substitution, identification of educational roles and needs, and recommended research--its costs and returns and time schedules); plant fibers other than wood and cotton; the textile industry (cotton, wool and mohair, the cellulosics and synthetic fibers); feathers; furs; and leather.

56929 (PB—264886) **Impact of the Federal tax code on resource recovery. Final report.** Anderson, R.C.; Spiegelman, R.D. (Environmental Law Inst., Washington, D.C. (USA)). Dec 1976. 358p. NTIS PC A16/MF A01.

The study assessed the extent to which a variety of federal tax subsidies to extractive industries effect the flow of materials to competing secondary materials industries. The impacts on virgin material supply for steel, paper, lead, copper, and aluminum industries were analyzed and flows of virgin and secondary materials characterized at points where they substitute as inputs to production. Econometric models were used to analyze the impacts on quantities of secondary materials recycled. It was estimated that the short-run effect of eliminating federal tax subsidies would increase the recycling of scrap steel by 0.42 percent; waste paper, 0.67 percent; lead, 0.75 percent; copper, 0.35 percent; and aluminum, 1.7 percent. The cumulative effect over the long-run from the elimination of the subsidies may be considerably larger if the impacts on investment and choice of technology decisions in the affected industries are included.

56930 **Energy and natural resources.** Grenon, M. *Rev. Energ.;* 28: No. 292, 175-182(Mar 1977). (In French).

The energy crisis is considered as part of a more general crisis in resources (including water, land, materials, manpower, etc.) The so-called WELMM method (Water, Energy, Land, Materials and Manpower) which analyzes the availability of natural resources and their interactions during economic or industrial processes is described.

56931 **Regional mineral developments.** Verity, T.V. (Can Dep of Energy, Mines and Resour). *Can. Min. J.;* 98: No. 2, 20-29(Feb 1977).

The federal and provincial governments agreed to carry out joint mineral development programs in 1970; currently six are in progress. The objective is to aid regional development by stimulating mineral exploration, development and further processing, and to improve social and economic conditions. The programs are jointly funded and managed by the federal and provincial governments and are implemented by the provincial departments responsible for minerals. Results of the programs are made available to the public at an early date. The improved geoscientific data base, together with

research and development and infractructure, provide incentives for private sector exploration and development activity.

56932 Canadian non-fuel minerals in the international scene and foreign policy. Fraser, D.B.; Cajka, C.J.; Koepke, W.E.; Ninacs, G.J. (Can dep of Energy, Mines and Res). *Can. Min. J.;* **98**: No. 2, 30, 32-33(Feb 1977).

Canada's total exports of nonfuel minerals and metals (consisting of three forms--crude, smelted and refined, and semi-manufactures) are estimated at $7.0 billion for 1976, based on 9-month data prorated for the full year. This compares with $5.7 billion in exports in 1975, an increase of $1.3 billion (23 percent). All sectors-- identified herein as the ferrous, nonferrous, and industrial minerals--contributed to the increase. Smelted and refineed nonferrous metals accounted for the bulk of the increase as their value of exports jumped 60 percent, while exports of nonferrous metal ores and concentrates declined slightly.

56933 Canadian reserves of seven metals. McIntosh, J.A.; Cranstone, D.A. (Can Dep of Energy, Mines and Resour). *Can. Min. J.;* **98**: No. 2, 39, 42, 44, 46(Feb 1977).

The accompanying bar graphs show the quantities of metal in economically mineable ore reserves at producing mines and deposits committed for production. The metals are copper, lead, zinc, nickel, molybdenum, silver and gold.

RESEARCH AND DEVELOPMENT

REFER ALSO TO CITATION(S) 56922

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 55852, 55865, 55883, 55893, 55897, 55899, 55934, 55954, 56361, 56534, 56582, 56583, 56590, 56741, 56743, 56977, 56978

56934 But what will be done with the high level radioactive waste. Surely man can improve on nature. *Electr. Perspect.;* No. 77/2, 11-15(1977).

The quantities of waste produced by nuclear power plants are argued to be so small, compared with combustion waste products of other fuels, that it is possible to store the wastes in an immobilized state until their radioactivity returns to that of the original ore. Conventional fuels produce waste products that cause nearly $20 billion in environmental damage and may lead to 20,000 premature deaths each year. Nuclear wastes can be solidified to a relatively small volume and placed in non-leaking glass or rock stable geologic formations for the 1000 years needed to reduce the radioactivity level. Double-wall tanks, which can be set in concrete vaults, have been developed since the first single-wall tanks were found to have developed some leaks. Demonstration plants for reprocessing spent fuels were developed in the 1960s. Ultimate disposal of both civilian and military wastes are underway with several field surveys scheduled for 1977. Four types of geologic formations to be studied are thick-bedded salt, salt dome, shale, and granite. Federal licensing for the first storage facility is expected in 1983-1985. (DCK)

56935 (PB—264611) **Some public finance aspects of nuclear energy centers. State and local public finance problems and prospects: Some implications of nuclear energy centers.** Weinstein, P.A. (National Governors' Conference, Washington, D.C. (USA). Center for Policy Research and Analysis). Apr 1976. 124p. NTIS PC A06/MF A01.

Prepared in cooperation with Maryland Univ., College Park.

Energy facilities characteristically have an impact on the areas where they are sited. A major generating station can alter the tax base in the county and the nature of public services to be provided. This particular study concentrates on the fiscal problems. It is intended as a first cut at the problem of how to apportion the revenues and the burdens which would exist if an energy park were to become a reality. Many of the problems which it explores apply equally to facilities in the energy field and elsewhere which are smaller than the nuclear park.

56936 Can we do without uranium. Weinberg, A.M. (Oak Ridge Associated Universities, TN). *Combustion;* **48**: No. 12, 12-18(Jun 1977).

From Conference on future strategies for energy development; Oak Ridge, TN, USA (21 Oct 1976).

The results of a study by the Institute of Energy Analysis: "Economic and Environmental Implications of a U.S. Nuclear Moratorium, 1985—2010" are discussed. The energy demand to 2010 is estimated. Alternative energy sources are discussed for the hypothetical case in which nuclear power is rejected and fossil fuel is gone or foresworn because of excess carbon dioxide production. An estimate is made of the energy obtainable from each of the renewable resources: geothermal, hydro, wind, waves and tides, sun, biomass, and solar electric systems. Factors effecting the plausibility of using breeder reactors are detailed. (DDA)

56937 Plutonium recycle's relation to the future of nuclear power. Hoskins, R.E. *Combustion;* **48**: No. 12, 19-23(Jun 1977).

From American Power Conference; Chicago, IL, USA (18 Apr 1977).

Estimated energy demands, supplies, resources, and power costs are given for the period from 1975—2025 in an effort to provide some perspective on nuclear options. The following nuclear options are considered: abandonment of nuclear power, stagnation of the growth of nuclear power, LWR only options with and without recycle, and variations of the LWR/LMFBR in tandem. The results of an economic analysis of each option are tabulated. (DDA)

56938 Health hazards of not going nuclear. Guccione, E. *Min. Eng. (N.Y.);* **29**: No. 4, 48-52(Apr 1977).

Nuclear safety is discussed including use of plutonium, waste disposal, and possible abuses of nuclear energy.

56939 Emerging role of FEA in nuclear energy expansion. Feinroth, H. (FEA, Washington, DC). *Energy Commun.;* **3**: No. 2, 159-170(1977).

A general survey of the activities of the FEA is presented along with definition of the roles of other government agencies such as ERDA and NRC. The author sees the role of the FEA as providing an overall basic domestic energy policy perspective.

CONSERVATION

REFER ALSO TO CITATION(S) 56910, 56915, 56924, 56925, 56928, 56949, 56980, 56981, 56984, 56987, 57012

56940 (PB—264635) **Organizing and operating a vanpool program: feasibility of vanpooling in Virginia. Final report.** Hoel, L.A.; Herrin, M. (Virginia Highway and Transportation Research Council, Charlottesville (USA); Virginia Dept. of Highways and Transportation, Richmond (UsA); Virginia Univ., Charlottesville (USA). Dept. of Civil Engineering). Oct 1976. 37p. (VHTRC—77-R15). NTIS PC A03/MF A01.

Prepared in cooperation with Virginia Dept. of Highways, and Transportation, Richmond, and Virginia Univ., Charlottesville. Dept. of Civil Engineering.

The report identifies the various elements of passenger transportation vanpool programs and describes the procedures necessary for employers and agencies to implement a vanpool program, based on Virginia conditions. The concept of vanpools is introduced and benefits to management and employees are identified. Among these are reduced needs for parking, reduced traffic congestion, lower commuting costs and conveniences. Employer concerns about vanpool implementation are discussed, such as legal aspects and insurance costs. In Virginia there are no serious legal problems to prevent vanpooling. Experience with vanpools elsewhere in the U.S. indicate that methods for managing and operating programs differ from one company to another, although the basic concept is similar to that selected by the 3M Company in its pioneering effort.

56941 (PB—265131) **Small bus program: vehicle operation efficiency report. Part I. experimental bus program (15-20 passenger buses). Part II. Van conversions for dial-a-ride service (12 passenger buses).** Fletcher, P.B.; Hewitt, C.H.; Pellonpaa, C.V.; Woodford, J.P. (Michigan Dept. of State Highways and Transportation, Lansing (USA)). Nov 1976. 170p. NTIS PC A08/MF A01.

A repot, prepared by the Michigan Department of State Highways and Transportation, Bureau of Urban and Public Transportation, describes the operational experience with some 15 vehicles produced by a variety of manufacturers. The report consists of a series of individual driver's and mechanic's reports on the actual performance of the vehicles in different Michigan communities. Each vehicle is evaluated on the basis of its economy, capacity, dependability, durability, and the general impression made on the public, drivers, and mechanics. The information was gathered as part of the Michigan transportation agency's experimental bus program (15 to 20 passenger vehicles) and its Dial-A-Ride Transportation (DART) program which uses converted vans (12 passenger) and is operating in some 28 Michigan communities.

56942 Energy-conservation standards loom for buildings and industrial processes. *Energy Res. Rep.;* 3: No. 7, 4-6(4 Apr 1977).

A question and answer session was held with two representatives of ERDA on the implications of mandated conservation in building codes and industrial processes. They indicated that utility commissions should take a longer view than interruptible service, which is costly to the industrial plants. The possibility of mandated conservation goals for industry is expected to be dependent on

industry's response to the voluntary program and the availability of fuels. Early results of a coil-coating process proposed in the model building code have demonstrated a lower first cost than standard construction. Industrial conservation programs, based on innovative technology, have a high energy saving goal of 50 percent of the energy now consumed before the end of the century. They stressed that more education of the financial community is underway, although individual banks have taken the initiative. More conservation effects are possible when the economy is healthy and plants are running on regular schedules. (DCK)

56943 Practical meaning of energy management. Buonassisi, C.E. (DuPont, Wilmington, Del). *Text. Chem. Color.;* **9**: No. 3, 15-18(Mar 1977).

Recent experience in consulting within the textile industry indicates that a further 20% reduction in energy consumption per pound of production is an achievable goal. The five prerequisites for a successful energy management program are reviewed as they relate to all of industry. Projected increases in energy costs are discussed as they affect production costs and selling price. Some examples of successful plant energy conservation measures reflect on the practical approaches that can and must be implemented in order to survive in the textile dyeing and finishing business.

56944 Energy conservation in dyeing and finishing. Wagner, R.E. (DuPont, Wilmington, Del). *Text. Chem. Color.;* **9**: No. 3, 19-21(Mar 1977).

Energy consumption calculations for dyeing and finishing operations for some typical fabrics have been examined to develop a list of recommendations for energy conservation actions. Each operation was studied to determine opportunities for energy conservation via salvage of waste energy or reduction of energy demand. A priority list of conservation action was then developed by estimating the cost of equipment or procedural change required to effect the energy saving, then calculating the payout period required to offset the investment required. 6 refs.

56945 Efficient energy utilization in the European Community: tasks, aims, and tools of the common policy of efficient energy utilization. von Scholz, H.E. (Komm der Eur Gem, Brussel, Belg). *Glueckauf:* **113**: No. 3, 138-147(3 Feb 1977). (In German).

Initial results of policy are evaluated based on main consumer sectors. Energy saving recommendations are explained and coordination of national and international measures is evaluated. 23 refs.

56946 Report from Berkeley. Dean, E. (Univ. of California, Berkeley). *IF (Ind. Forum);* **7**: No. 2-3, 75-82(1976).

Energy conservation should not be confused with a reduction of living standards. A study program was organized to address the question of improving the efficiency of buildings ("passive mode") regarding energy use, for heating and cooling, and yet maintain building quality. Buildings are extravagant consumers of energy; strategies for maximum energy efficiency are not well understood. In commercial buildings, most of the primary energy is electricity, of which at least one third is for lighting; sensible use of day lighting can significantly reduce this load. Recommended ventilation standards are often unnecessarily high; in regions with long intermediate seasons, natural ventilation allows energy to be saved—provided there is not too much traffic noise. In residential buildings, heating is the major consumer of energy; whole-house performance is often inaccurately understood, particularly concerning internal ventilation, "natural" energy storage, and the effects of single- or double-glazed windows. Orientation has a significant effect. A computer model has been developed, allowing detailed displays of heating performance and energy consumption. Long-term economic implications of design decisions can then be assessed.

56947 Energy savings via behavioral changes. Pilati, D.A. (Univ. of Illinois, Urbana). *IF (Ind. Forum);* **7**: No. 2-3, 103-106(1976).

Energy requirements for heating and cooling homes depend strongly on how the conditioning equipment is used. Residential energy demand in price-sensitive; it is not certain if it is price-elastic. Behavioral change can reduce consumption at no capital cost; it is uncoupled from technological change. Using computer simulations, savings in heating (by decreased thermostat settings) and cooling (by increased settings and by natural ventilation) can be evaluated; amounts, while considerable, are highly dependent on local climates.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 56909, 56923, 56926, 56964, 56966, 56968, 56982, 56983, 57001, 57013

56948 (EPRI-EA—462) **Regional reference energy systems.** Hermelee, A.L. (Brookhaven National Lab., Upton, N.Y. (USA)). Jun 1977. Contract EY-76-C-02-0016. 342p. Dep. NTIS, PC A15/MF A01.

A regional energy systems formulation incorporating an integrative view of the energy system such that all resources, technologies, and uses of energy are set forth in a uniform manner is presented here. This approach, based on the Reference Energy System (RES), is broadly applicable to the assessment of energy technologies and policies at a regional level. Reference Energy Systems have been developed for each of the nine census regions and summaries of the regional data for the entire United States are given. RES's were formulated for the base year 1972, and projections were developed for 1980, 1985, and 2000. The RES and associated data provide a baseline against which the substitution of alternate technologies and policies can be evaluated. The Reference Energy System incorporates a detailed disaggregation of regional energy demands in the Residential, Commercial, Industrial, and Transportation Sectors. The regional supply of fossil fuels, including the supply of electricity by type of generating plant, is projected through the year 2000.

56949 (NP—21880) **Energy and Virginia's future: a report of the Virginia Energy Resource Advisory Commission.** (Virginia Energy Resource Advisory Commission, Richmond (USA)). 26 Oct 1976. vp. Energy Resource Advisory Commission, Richmond, VA.

In order to present the seriousness of the energy situation, an overview of the national energy situation is reviewed in Part I. Such areas as historical aspects, use patterns, resource base, production, prices, demand factors, public issues, and outlook for petroleum, natural gas, coal, hydroelectric power, electric power from primary thermal energy sources, and nuclear energy are examined. In Part II, Energy in Virginia, demand and supply data are summarized for petroleum, natural gas, coal, and electricity. Solar energy as an emerging energy technology is discussed followed by a discussion on energy conservation as practiced and planned in Virginia. (MCW)

56950 (PB—264069) **Project Independence evaluation system (PIES) documentation. Volume VI. Methodology for improving the price sensitivity of the PIES oil and gas supply curves.** (ICF, Inc., Washington, D.C. (USA)). Sep 1976. Contract FEA-CO-05-50301-00. 51p. NTIS PC A04/MF A01.

See also Volume 1, PB—263020.

This report develops a methodology for improving the price sensitivity of the oil and gas supply models used in Project Independence analyses. It focuses on the question of improving the responsiveness of supply from currently existing proved reserves to changes in output prices.

56951 (PB—264649) **Project Independence evaluation system (PIES) documentation. Volume VII. Methodology for developing more complex investment and production profiles in the FEA oil and gas supply model.** (ICF, Inc., Washington, D.C. (USA)). Sep 1976. Contract FEA-CO-05-50301-00. 24p. NTIS PC A02/MF A01.

See also Volume 6, PB—264069.

This report investigates the possibility of altering the oil and gas supply models to utilize more complex investment and production profiles, especially in frontier oil and gas provinces. The assumptions used in the models with respect to timing of investment and production are acceptable for mature oil and gas provinces, but are less so for frontier production areas. Investment leadtimes and rates of production build-up are slower in virgin provinces, which leads to underpriced petroleum and overestimated production in these areas.

56952 (PB—265108) **International comparisons of the residential demand for energy: a preliminary analysis (World Oil Project).** Pindyck, R.S. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Sep 1976. 89p. (MIT/EL—76/023WP). NTIS PC A05/MF A01.

This paper reports on some initial results from an econometric study of the world demand for energy. It examines some preliminary estimates of inter-country differences in the structure of demand in the residential sector. Residential demand models are designed on the assumption that consumers make two decisions in purchasing fuel: (1) what fraction of their total budgets will be spent on energy; and (2) which fuels to purchase. Section 2 outlines specifications of various models of residential energy demand, and describes the characteristics of each specification. Section 3 discusses some methodological issues in the estimation of energy demand models using pooled data. The issues discussed include the use of purchasing power parities to make international comparisons, the question of accounting for thermal efficiencies in the use of energy consumption data, the formulation of an aggregate price index for energy, and the use of alternative estimation methods. Section 4 describes some of the characteristics and limitations of the data. Section 5 includes the statistical results.

56953 Ultimate energy requirements for small consumers. Kolar, J. (Tech Univ, Munich, Ger). *Energie;* **28**: No. 11, 331-334(Nov 1976). (In German).

Guidelines for planning of energy supply and network to be used by workshops, public buildings, hospitals, schools, theaters,

etc., based on statistical data in the Republic of Germany, are presented. It was determined that 1.8 MWh is required annually per capita for energy, excluding electric power. 12 refs.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 56929, 56937, 56945, 56948, 56951, 56961, 56969, 56972, 56985

56954 (BNL—22730) **Overview of technological-economic models for energy policy analysis.** Behling, D.J. Jr.; Cherniavsky, E.A.; Hoffman, K.C.; Jorgenson, D.W. (Brookhaven National Lab., Upton, N.Y. (USA); Harvard Univ., Cambridge, Mass. (USA)). 1977. Contract EY-76-C-02-0016. 29p. Dep. NTIS, PC A03/MF A01.

A combined technological-economic model has been developed and applied to the analysis of energy policies. The individual models that have been assembled are the Hudson-Jorgenson model of the economy and interindustry transactions, and the Brookhaven Energy System Optimization Model. Other data bases and fixed coefficient input/output models are employed as data sources and accounting frameworks to support this combined technological-economic model. The combined model has been used to develop long-range projections of energy-economic relationships and to perform cost/benefit analyses of the U.S. energy R and D programs.

56955 (NP—22250) **Energy scenarios for New Zealand. Report No. 19.** Harris, G.S.; Ellis, M.J.; Scott, G.C.; Wood, J.R.; Phillips, P.H. (New Zealand Energy Research and Development Committee, Auckland). Mar 1977. 149p. Dep. NTIS, PC A07/MF A01.

The themes of the three scenarios chosen for this study are for continuation, low New Zealand pollution, and limited growth. The continuation scenario comprises extension of past trends, policies, and attitudes, essentially unchanged for 50 years; i.e., it is continued economic growth with emphasis on industrialization. This should not be interpreted as a forecast, but rather an indication of what could happen with economic growth similar to pre-1974 rates. The low New Zealand pollution scenario calls for the minimization of pollution in New Zealand as a primary objective in governmental, business, and personal decisions and a small amount of economic growth is sacrificed in order to achieve this. The limited growth scenario represents a strategy for New Zealand in a world which is beset by resource depletion, environmental degradation, insufficient energy supply, and the social and economic consequences of rising population. New Zealand's dependence on the rest of the world for energy and other resources is reduced by lower population growth, slow economic growth, and switching to indigenous renewable resources. The three scenarios may be considered to define, within reasonable limits, the bounds within which New Zealand's future energy policy may lie, although it would certainly be possible to construct scenarios with themes that result in higher or lower energy growththan those studied here. The results of this research are considered by the authors to provide a good indication of the outcome of any alternative related theme. (MCW)

56956 (PB—264575) **State taxation of mineral deposits and production. Final report.** Stinson, T.F. (Economic Research Service, Washington, D.C. (USA); Minnesota Univ., St. Paul (USA)). Jan 1977. 53p. NTIS PC A04/MF A01.

Prepared in cooperation with Minnesota Univ., St. Paul.

Development of energy resources in the more rural western states is likely to create severe financial problems for some state and local governments. This new economic activity, with population inmigration and greater demand for public services, will generate a need for more government revenues. Increased use of mineral taxation is one way of financing the new services without increasing the tax burden on the area's existing residents. Four mineral taxes--ad valorem, severance, gross production, and net production--are described and evaluated. Taxes are compared on the basis of ease of administration, social justice, consistency with national economic goals, and revenue adequacy. Some states have enacted special programs designed to ease the front end problem. Programs in Montana, North Dakota, Utah, and Wyoming are discussed but not evaluated.

56957 (PB—265364) **The report to Congress: waste disposal practices and their effects on ground water. executive summary. Final report.** (Environmental Protection Agency, Washington, D.C. (USA). Office of Water Supply). Jan 1977. 52p. (EPA—570/9—77/002). NTIS PC A04/MF A01.

See also full report, PB-265 081.

This document summarizes the report, 'Waste Disposal Practices and Their Effects on Ground Water'. All material presented in the Executive Summary is duplicated in the full Report so that it will stand alone as a complete document.

56958 (PB—265447) **Local regulation of pipeline sitings and the doctrines of Federal preemption and supremacy.** Hershman, M.J.; Fontenot, D.R. (Louisiana State Univ., Baton Rouge (USA)). 1976. 19p. (LSU-R—76-013). NTIS PC A02.

Pub. in Louisiana Law Review, v36 n4 p929-945 1976.

State and local legislative action will not create any new rights for local governments attempting to regulate pipeline sitings when confronted with conflicting desires of industry or federal regulations, but will simply make existing rights easier to assert and defend. The final arbiter of any dispute will be the Constitution as interpreted by the courts.

56959 **Energy policies of France Great Britain, and Germany compared.** de Carmoy, G. (INSEAD, Fontainebleau, Fr). *Rev. Energ.;* **28**: No. 292, 160-164(Mar 1977). (In French).

France, Great Britain, and Germany have unequal natural resources and are therefore unequally dependent on foreign supplies. This article presents the energy situation in the three main industrial countries of Western Europe as well as their strategies in the field of energy savings. One of the lessons of the energy crisis is the re-examination of the role of coal in the economies of the industrialized countries. Coal adds security concerning supplies. England, France and Germany are trying to either increase their coal production or slow down its regression in terms of their own resources.

FOSSIL FUELS

REFER ALSO TO CITATION(S) 55656

56960 **Equivalence between electricity and fuels: elements for a critical discussion.** Ramain, P. (CNRS, Fr). *Rev. Energ.;* **28**: No. 292, 165-174(Mar 1977). (In French).

The choice of an equivalence between electricity and fuels in the energy balance is considered. It is noted that the notion of equal service rendered is a logical method that should be used but applied with caution. Wide research has to be undertaken, or continued, but it is first of all absolutely necessary to agree on the following: at what level can the service be situated, and what terms can be used to measure it. More fundamentally, the difficulties that may be encountered in the determination of punctual coefficients of equivalence (for example, concerning a well determined service) should not lead one to abandon all innovations in methodology on a more global level.

COAL

REFER ALSO TO CITATION(S) 55546, 55566, 55570, 55590, 55603, 55604, 55605, 55606, 55607, 55608, 55614, 55615, 55731, 55739, 55740, 56959, 56976, 56978, 57025

56961 (PB—265815) **Coal conversion program: Energy supply and Environmental Coordination Act (as amended). Section 2. Draft environmental statement.** (Federal Energy Administration, Washington, D.C. (USA)). Feb 1977. 622p. (FEA/G—77/061;DES—77/3). NTIS PC A99/MF A01.

This statement discusses the Federal Energy Administration's authorities under ESECA, as amended by PL 94-163, to issue orders to fossil fuel-fired facilities prohibiting them from burning natural gas or petroleum products as their primary energy source and requiring facilities in the early planning process to be built with the capability of burning coal, and the probable environmental impacts associated with issuing such orders.

56962 **Underground gasification offers clean safe route to coal energy.** Jenkins, N. *Energy Int.;* **14**: No. 4, 28-30(Apr 1977).

Underground gasification offers the possibility of a return to coal in a form more acceptable to consumers. Estimates of an 84 percent extraction efficiency make in situ processing attractive if technology can be developed for a faster rate of production and enrichment to offset the low calorific value. The advantages of in situ gasification include safety, cleanliness, lower cost of pipeline transmission, and the possibility of exploiting thin and otherwise inaccessible seams. Two new process proposals for controlling oxygen and combustion are based on the use of hydrogen instead of oxygen as a heat supplier and on the explosive fracturing of the seam before burning. Estimates of costs show these new processes are not competitive, but are in line with costs of imported natural gas. The reluctance of miners to work underground and the increasing costs of mine safety and improvement will increase the attractiveness of underground gasification. New developments will seek to combine coal fields with a 20-year life expectancy and 100-megawatt cogeneration power plants in proximity to an urban center. (DCK)

56963 **New developments in the French coal plan.** Gardent, P. (Charbonn de Fr, Paris). *Glueckauf;* **113**: No. 4, 157-163(17 Feb 1977). (In German).

Problems of manpower and production increases are discussed, together with investments in new programs. Technical elaboration of reactivating old mines is followed by discussion of economic and political considerations of energy resources.

56964 Contribution of coal to the energy supply of France. Huchet, R. *Glueckauf;* **113**: No. 4, 163-173(17 Feb 1977). (In German).

Present energy resources and long-range development plans are reviewed. Supply and consumption statistics are analyzed, and coal utilization in electric power generation and industrial plants is discussed. 5 refs.

56965 Present situation of the European Community coal mining industry. Reichert, K. (Komm der Eur Gem, Brussels, Belg). *Glueckauf;* **113**: No. 4, 233-244(17 Feb 1977). (In German).

Overall review of reserves, utilization for energy production and in industrial plants and households is presented. Pricing and developments in supply, investments, employment, productivity, and costs are evaluated, and coal imports to the Community are analyzed.

56966 Low-Btu gas from coal has many potential markets. Korens, N. (Stanford Res Inst, Menlo Park, Calif). *Pipeline Gas J.;* **204**: No. 2, 30, 32-34, 36(Feb 1977).

The author makes an assessment of the market potential for low-Btu gas from coal, and shows that making this gas for use in boilers and small furnaces has many advantages over direct coal utilization. Major areas include using low-Btu gas for fueling gas turbines and in combined-cycle generating plants. End-use economics for alternative fuels are discussed for the industrial fuels and the electric power generation sectors. 9 refs.

56967 World coal resources and the role of coal in energy savings at the end of the century. Sore, J.C. (Charbonnages de Fr). *Rev. Energ.;* **28**: No. 291, 61-71(Feb 1977). (In French).

It is shown that the world's existing coal resources are a guarantee enabling humanity to satisfy its energy needs while developing more recent forms of energy. The abundance and location of coal resources can make it possible to stabilize the market prices. In the nuclear age entered since the 1973 crisis, coal can play a supporting and necessary role. The major programs envisaged in the major producing countries prove to be feasible up to the end of the century without considerably depleting the reserves. Nevertheless, these programs imply considerable development of world trade. A basic requirement is a certain degree of order on the market requiring the signing of long-term contracts with the producers and sufficient coordination of investments.

56968 International coal trade. Soudet, P. (Assoc Tech de l'Import Charbonniere, Fr). *Rev. Energ.;* **28**: No. 291, 72-77(Feb 1977). (In French).

Today, the role played by coal, which was fundamental in the system of exchange in the 19th century and at the beginning of the 20th century, has truly been revived, especially owing to the effect of the recent changes in the energy world. The article is centered around four aspects: the present situation of the world coal trade; France's position with respect to this situation; the specific features of the coal exchange from the political, technical, and commercial standpoint; and finally, a conservative attempt at making a forecast.

PETROLEUM

REFER ALSO TO CITATION(S) 55703, 55756, 55792, 55795, 55816, 56917, 56950, 56952, 56958

56969 (AD-A—037807) **Petropolitics and the Atlantic Alliance.** Szyliowicz, J.S.; O'Neill, B.E. (National Defense Univ., Washington, D.C. (USA). Research Directorate). Nov 1976. 28p. NTIS PC A03/MF A01.

More than three years have passed since the petroleum crisis of 1973 forced the United States to confront the multifaceted challenge posed by an impending imbalance between energy supply and demand. The crisis posed two special problems for the West regarding the linkage between energy and the security of the Free World. First, the recognition that military power is sustained by the economic strength of the alliance partners and, at present, is contingent upon an adequate supply of petroleum. The second centered around the danger that the greater dependence of the European states and Japan on imports of oil could lead to beggar-thy-neighbor competition and tend to undermine the cohesion of the Western alliance. The United States reaction to the latter issue is the subject of this first National Defense University monograph on national security affairs. In it, Professors Joseph S. Szyliowicz and Bard E. O'Neill have reviewed the interaction between the United States and its allies. They have described short- and long-term effects of the crisis on American-European relations and suggested several factors to account for changes that occurred.

56970 (PB—265015) **OPEC and the monopoly price of world oil (World Oil Project). Working paper.** Cremer, J.; Weitzman, M.L. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Apr 1976. 22p. (MIT/EL—76-015WP). NTIS PC A02/MF A01.

Prepared in cooperation with Alfred P. Sloan School of Management, Cambridge, Mass.

The report presents a dynamic model of the behavior of OPEC viewed as a monopolist sharing the world oil market with a competitive sector. In order to study the influence of long-term considerations on the price of oil, a dynamic model of the capital theoretic type was built.

56971 (PB—265093) **Dynamics of petroleum industry investment in the North Sea. (World Oil Project).** Beall, A.O. Jr. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Jun 1976. 86p. (MIT/EL—76/007WP). NTIS PC A05/MF A01.

Thesis.

This report provides an estimate of the oil potential of the northern North Sea from which estimates of exploration investment, development investment, and accruing cash flows can be derived.

56972 (PB—265143) **Impact of mandatory petroleum allocation, price, and other regulations on the profitability, competitive viability, and ease of entry of independent refiners and small refiners.** (Federal Energy Administration, Washington, D.C. (USA)). Mar 1977. 106p. (FEA/G—77/105). NTIS PC A06/MF A01.

The report presents information on the structure of the U.S. petroleum refining industry. It describes specific characteristics of the industry. It discusses competition in the industry and the ease of entry for the small refiner and the independent refiner. Government regulations that impact on small and independent refiners are described. The effects of FEA regulations and other pertinent Government programs on the profitability of small and independent refiners are addressed.

56973 Oil industry in Scotland. Wilson, G. *Pet. Rev.;* **31**: No. 362, 13-15(Feb 1977).

The author argues that United Kingdom oil policies have been arrived at by successive governments from the perception that the fastest possible buildup of oil production is necessary if the United Kingdom is to reach the point of self-sufficiency when the oil element in the endemic balance of payments deficit is eliminated. To the achievement of this object, all other aspects of oil policy such as taxation, effective participation, downstream development, marketing of natural and other gases and long-term depletion and conservation have been subordinated. Besides offering alternative to current policies, the author briefly cites the consequences, for the United Kingdom petroleum industry and Scotland's economy, of Scottish independence.

NATURAL GAS

REFER ALSO TO CITATION(S) 55756, 55814, 56950, 56958, 56973

56974 Support grows for trans-Australia gas pipeline. Scott, W.E. *Energy Int.;* **14**: No. 4, 21-23(Apr 1977).

A nationwide pipeline network to carry natural gas from Australia's North-West Shelf to eastern states is gaining in popularity, according to a recent report. Engineering and economic feasibility studies support a transcontinental system that would meet energy demands until the end of the century. An estimated 6400 km of pipeline is needed. A 20-year agreement for liquefied natural gas (LNG) exports has not yet been settled because of government concern over projected acceptable shortfalls in the local market. Justification for pipeline routes is reviewed, with competition date for the first section set at 1982 and connection with the North-West Shelf by 1991. Production goals will be geared to having supplies available for the mid-1980's, however, as a strategic reserve in the event of disaster or accident. Widespread public discussion will be encouraged by the pipeline company to allow full public input to government policy decisions. A uniform pricing schedule to each of the capitols will be set even though construction and operating costs will vary. Reserve estimates of proven fields indicate that extensive exploration of probably and possible reserves is needed to meet demand growth beyond the year 2000. The discovery of additional reserves will relieve the anticipated shortfall from LNG export. (DCK)

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 55851

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 55594

ELECTRIC POWER

REFER ALSO TO CITATION(S) 56960

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 56966, 56983, 56987

56975 (PB—265 641) **Impacts of the western drought on regional electricity generation. Interim report.** (Federal Energy Administration, Washington, D.C. (USA)). 31 Mar 1977. 116p. (FEA/D—77/128). NTIS PC A06/MF A01.

Prepared in cooperation with Federal Power Commission, Washington, D.C.

This report examines the projected electrical demand and power supply situation in the West generally, and in the states of Washington, Oregon, Idaho and California particularly, mainly for the summer of 1977. The reduced water supplies caused by drought conditions have created the prospect of inadequate hydroelectric supplies and the need for other measures to respond to regional electricity demands. These conditions are reviewed and the results summarized.

56976 (PB—264769) **Status of coal supply contracts for new electric generating units, 1976—1985.** (Federal Power Commission, Washington, D.C. (USA). Bureau of Power). Jan 1977. 42p. NTIS PC A03/MF A01.

Electric utility coal consumption is projected to increase 90 percent in the next decade--from approximately 406 million tons last year to 770 million tons in 1985. The report is based on utility industry plans to construct 229 new coal-fired units with total generating capacity of 111,600 megawatts during the period.

56977 **Mergers create single French sources for nuclear, fossil, hydro plants.** Jeffs, E. *Energy Int.;* **14**: No. 4, 25-27(Apr 1977).

Manufacturers and suppliers of French power plants and equipment are negotiating mergers so that there will be a single manufacturer of major power plant components. The mergers, involving three French and one Swiss engineering groups, began after the 1973 oil crisis as a move from an oil-based to a nuclear-based energy system. For the Alsthom and Creusot Loire groups this resulted in substantial expansion to fill increased work orders. Chantiers de l'Atlantique, which had suffered a drop in shipping business and orders for diesel engines, was able to increase sales of diesel equipment as backup for the nuclear systems. CEM-Compagnie Electromecanique was the fourth company to join in the steps leading to the mergers. The reorganization of these companies and their subsidiaries resulted in collaborations to produce turboalternators, water turbines, nuclear reactors, and complete power stations. A second group handles commercial, but no manufacturing, processes. The French breeder reactor program is based primarily on the Super Phenix prototype, while another company (Framatome) continues with the light water reactor. The new arrangements are felt to offer more stability to the industry and a better market response capability. Procedures have been simplified and centralized. (DCK)

56978 **Use of coal in power plants.** Ippolito, M. (Charbonnages de Fr). *Rev. Energ.;* **28**: No. 291, 102-110(Feb 1977). (In French).

After pointing out that coal still supplies half the world's power plants, the question is asked whether this present situation guarantees the future. Taking account of electricity consumption and nuclear energy production scenarios, the position that fossil fuels could hold in the supply model from now until the end of the century, both throughout the world and at the level of large complexes, is analyzed. It is shown that the recourse to solid fuels appears indispensable to stabilize the system and enable safe development of nuclear programs.

56979 **Power industry in the first year of the tenth five-year plan period and the tasks for 1977.** Borisov, E.I. (Minist of the Electrotech Ind, USSR). *Teploenergetika (Moscow);* No. 1, 2-3(Jan 1977). (In Russian).

The output of electric power in the USSR increased by 7% in 1976 and topped 1100 billion kWh. Heat delivery by power plants amounted to 760 million Gcal, which is 13% more than in 1975. By the end of 1976 there were 359 large boiler units in operation, six of which were 800 MW, three 500 MW, and one hundred thirty-five 300 MW capacity each. Some plans for 1977 and shortcomings in the power industry are described.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 56915, 56944

56980 (CONS/2103—3) **European waste-to-energy systems: case study of Koersor, Denmark.** (Resource Planning Associates, Inc., Washington, D.C. (USA); Resource Planning Associates, Inc., Paris (France)). May 1977. Contract EX-76-C-01-2103. 37p. Dep. NTIS, PC A03/MF A01.

Koersor, Denmark operates a waste-to-energy system for only 20,000 persons. Energy is recovered in the form of heat for district heating and the facility has been operating reliably for about four years. The apparent success of this installation suggests that the system may have applications in smaller communities. The design and operation of the facility are summarized. The energy recovered from the boiler amounts to about 7,000 kilotherms (kth) per year. The thermal efficiency of the plant is estimated at approximately 50 percent. Taking into account energy which is lost because it cannot be sold, the overall efficiency decreases to approximately 30 percent. The total cost of the complex was 7,000,000 Kr ($944,700; 1971 or $1,437,600; 1976) with 4,600,000 of that sum going for the incinerator. There was no subsidy from the Danish government; the plant was entirely financed with municipal funds. The overall cost of incineration is estimated today at 120 Kr per metric ton ($18 per short ton) including both capital and operating cost, after making provision for the value of heat recovered. (MCW)

56981 (CONS/2103—4) **European waste-to-energy systems. Case study of Munich: Munich North IA and IB, Munich North II, Munich South IV and V.** (Resource Planning Associates, Inc., Washington, D.C. (USA); Consultex, S.A., Geneva (Switzerland)). May 1977. Contract EX-76-C-01-2103. 92p. Dep. NTIS, PC A05/MF A01.

The city of Munich has a population of 1,315,000. Solid waste is collected by a city department and delivered to the city's own Electricity Works. The Electricity Works incinerates the waste in five incinerators in two separate locations (the North and South plants). Munich's five incinerators represent three different designs for co-generation of heat and electrical energy. All burn both waste and fossil fuel and all use Benson boilers to produce steam at 184 bars (181.5 atm) and 540°C (1,000°F). The Electricity Works recovers energy in the form of electricity, hot water, and steam. Ash, bulky objects, and non-incinerable waste are dumped on a "garbage mountain" within the city limits. The system's priority is to produce electricity for the city grid rather than to treat waste. The hot water and steam produced are used in district heating. The system is peakloaded both for electricity and for district heating, and, as a result, is operated with some diseconomy. Over 450,000 metric tons (495,700 short tons) of waste were burned in 1975. That amount represents practically all the solid waste collected in Munich. A shredder with a capacity of 30,000 metric tons (33,000 short tons) per year will be added in 1977 and this will allow for even more complete incineration in the future. Some fees for collection go towards the difference between the total costs ofincineration and the revenue earned from the sale of energy and scrap metal. The rates charged appear to be far below actual costs of incineration, which suggests that the sale of electricity is subsidizing the cost of incineration.

56982 (LA—6770) **Energy flow patterns for 1975.** Kidman, R.B.; Barrett, R.J.; Koenig, D.R. (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1977. Contract W-7405-ENG-36. 72p. Dep. NTIS, PC A04/MF A01.

Highly visual and self-explanatory 1975 energy flow diagrams are presented for each of the 50 states, the 10 US Federal Standard Regions, and the entire United States. Each diagram illustrates the energy produced and how it is consumed or lost. The diagrams are meant to serve as a convenient and useful reference (or starting point) for consideration of energy-related problems.

56983 **Primary energy consumption of the Federal Republic of Germany in 1976.** Gabel, R. *Glueckauf;* **113**: No. 4, 245(17 Feb 1977). (In German).

Comparison of the share of various energy sources in the energy supply in 1975 and 1976 is made.

56984 **Energy, environment, management, and systems.** Ramsey, R.R. (Leo A. Daly Co., Omaha). *IF (Ind. Forum);* **7**: No. 2-3, 27-33(1976).

Buildings are major users of energy; energy conservation may not answer the problem if it leads to a reduction of standards. Current guidelines often set rigid and arbitrary levels of requirements. Energy management begins with a study of users' functional requirements, embodied in performance specifications. The General Services Administration has been approaching these problems through the combined use of performance specifications, building systems, and life-cycle costing. It is then possible for the systems contractors to design exactly to requirements; the inducement lies in the scope of the contracts they are bidding for. Life-cycle costing demands the consideration of selected dynamic factors. Computer simulations enable proposals to be fairly compared. Lessons from the industrial revolution point to the importance of inventiveness.

UNCONVENTIONAL SOURCES AND POWER GENERATION

56985 (CONF-770560—) **Proceedings of the public meeting to review the status of the inexhaustible energy resources study.** (Energy Research and Development Administration, Washington, D.C. (USA)). 18 May 1977. vp. Dep. NTIS, PC A04/MF A01.

From Public meeting to review the status of the inexhaustible energy resources study; Washington, District of Columbia, United States of America (USA) (18 May 1977).

The Inexhaustible Energy Resources Study was requested by ERDA Acting Administrator Robert Fri to examine inexhaustibles as a class. The purpose of the study was to determine how soon inexhaustibles are needed; to formulate strategies for their development and deployment; to identify alternative paths to the utilization of the inexhaustible resources; to serve as a guide in formulating ERDA budget requests; and to project funding profiles associated with each strategy. Dr. James Kane, coordinator of this public meeting, after speaking briefly, introduced Robert Fri, who opened the meeting. Speakers who followed Dr. Fri included Mr. Donald A. Beattie, Acting Assistant Administrator for Solar, Geothermal, and Advanced Energy Systems; Mr. Robert Thorne, Acting Assistant Administrator for Nuclear Energy; Dr. James Leverman, Assistant Administrator for Environment and Safety; and Dr. Bennett Miller, Executive Director, Inexhaustible Energy Resources Study. A question and answer period followed the presentations. (MCW)

56986 (NP—22295) **Report on the Western Energy Expansion Study.** (Bureau of Reclamation, Washington, D.C. (USA)). Feb 1977. vp. TIC.

This report contains the results of an assessment by the Bureau of Reclamation of opportunities to respond to urgent needs for additional electrical power and energy in the West which can make an effective contribution to conservation of dwindling oil and natural gas resources. The WEES was conducted to identify and evaluate opportunities for increased electrical power and energy generation in the 17 western states which warrant further, more detailed study in the immediate future. Focus of the study was primarily on development of hydroelectric power, including pumped storage, at both new sites and existing facilities. Other opportunities relate to devopment of electrical energy using solar (direct radiation and wind) and geothermal resources. In addition to developmental opportunities, several matters of a policy nature are discussed and evaluated. (MCW)

SOLAR

REFER ALSO TO CITATION(S) 56017, 56018, 56019, 56020, 56021, 56026, 56103, 56108, 56109, 56117, 56138, 57012

GEOTHERMAL

REFER ALSO TO CITATION(S) 56169

OTHER

REFER ALSO TO CITATION(S) 55999, 56219, 56926, 56927, 56980, 56981, 57022

56987 (CONS/2103—2) **European waste-to-energy systems: case study of Geneva-Cheneviers (Switzerland).** (Resource Planning Associates, Inc., Washington, D.C. (USA); Resource Planning Associates, Inc., Paris (France); Consultex, S.A., Geneva (Switzerland)). May 1977. Contract EX-76-C-01-2103. 41p. Dep. NTIS, PC A03/MF A01.

The City of Geneva, population 159,000 is the administrative center of the Canton of Geneva, population 340,000. The Canton owns a number of facilities for the treatment of waste. Geneva's chief waste treatment facility is the Cheneviers Incinerator. Two Von Roll integrated boiler incinerator furnaces have a rated capacity of 200 metric tons (220 short tons) per day each. Superheated steam at 360°C and 32.4 bars (32 atm) powers a 6200 kW turbo-generator unit. The electricity is sold to the cantonal grid. Total incinerable waste in the Canton of Geneva has varied from 120,000 to 130,000 metric tons (132,000 to 144,000 short tons) annually during the last five years. For the last two years, total per capita tonnage have been declining. Per capita incinerable waste was 363 kilograms (800 lbs) in the year 1975, of which 257 kilograms (606 lbs) were household waste. Eighty-seven thousand, five hundred metric tons (96,386 short tons) of this waste was burned in the Cheneviers Incinerator in 1975. The remainder was landfilled, due to the lack of capacity at the incinerators. The system which began operating in 1966, cost approximately 40 million Swiss Francs ($9.3 million; 1965 or $23 million; 1976). Three-quarters of this sum was for land, buildings, construction, and equipment. A large station and dock for the transfer of waste accounted for the remainder. The Von Roll design ofthis plant is now out of date. Extensive modifications were made to correct corrosion problems in the furnace.

ENERGY CONVERSION

MHD GENERATORS

DESIGN AND DEVELOPMENT

56988 (TID—27147) **CDIF combustor Instrumented Test Section. Final report.** Luce, R.G.; Wilkinson, W.H.; Boiarski, A.A.; Robinson, R.E.; Grinberg, I.M. (Battelle Columbus Labs., Ohio (USA)). 8 Sep 1976. Contract W-31-109-ENG-38. 156p. Dep. NTIS, PC A08/MF A01.

The national program for the development of open-cycle MHD power generation is directed toward a demonstration of the commercial applicability of the technology by means of the operation of an Engineering Demonstration Plant on an electric utility line. In order to provide the engineering information necessary for the successful design, construction, and operation of the Engineering Demonstration Plant, components will be tested in an integrated system to obtain long-duration operation of an open-cycle MHD system using a Component Development Integration Facility (CDIF). Argonne National Laboratory (ANL) has responsibility to prepare a conceptual design of a coal-fired open-cycle MHD CDIF for siting at Butte, Montana. To assist ANL in the implementation of this effort, BCL has conducted a 3-month program to provide the conceptual design of the Instrumented Test Section (ITS) which will be used in the evaluation of the performance of selected 25 MW thermal coal-fired MHD combustors. Results of this study are presented.

56989 (TID—27149) **Conceptual design of a CDIF Instrumented Test Section.** (MEPPSCO, Inc., Boston, Mass. (USA)). Oct 1976. Contract W-31-109-ENG-38. 276p. Dep. NTIS, PC A13/MF A01.

The purpose of the Instrumented Test Section (ITS) is to assist in the evaluation of candidate developmental MHD coal fired combustion chambers which will be subjected to long duration testing at the Component Development and Integration Facility (CDIF). The basic features of the ITS Conceptual Design are discussed in detail including constraints on ITS design imposed by the high pressure, velocity, and enthalpy as well as the presence of the slag. A description of the ITS gas train, diagnostic technique categorization, temperature measurement, electron density measurements, electrical conductivity measurements, laser Doppler velocimeter, velocity correlator, in situ composition, analysis by withdrawn sample, dynamic pressure, optical parts, traversing equipment, and average conductivity determination is given. Also, a utilities summary is given, and protection from failures and codes and standards are discussed. Also a systems analysis is presented including a cooling system analysis, structural analysis, and an analysis of the thermodynamic properties of reference combustion products. A program plan and schedule is included. (WHK)

56990 **Some results of investigations with the U-25 pilot plant to bring it up to design parameters.** Kirillin, V.A.; Sheindlin, A.E. *Teploenergetika (Moscow);* No. 12, 2-7(Dec 1976). (In Russian).

Some basic results of the work carried out in the last few years on the development of the U-25 (20.4 MW) MHD generator to bring it up to the rated capacity, are described. In particular, the work on improving the equipment and technological processes, investigating the operation of high heat-stressed combustion chambers and ionizing additive feeding and discharge systems is described. Much attention is devoted to the investigation of the operation of MHD generator channels and problems of inversion of dc into ac. 9 refs.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 56990

56991 **Mixture formation in diesel engines.** Gavrilov, B.G. (0800). *Energomashinostroenie;* No. 9, 12-14(1976). (In Russian).

The physical and chemical principles of mixture formation in diesel engines, in which the pre-flame period conditions prevent transition of diesel fuel hydrocarbons into the vapor phase without their decomposition are set forth. Experimental data confirming the correctness of this concept are presented.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 56988, 56989, 56998, 57740

56992 Investigation of the high-temperature recuperator of closed-cycle power plants operating on an inert gas. Tishchenko, Z.V. *Energomashinostroenie;* No. 1, 22-26(1977). (In Russian).

Results are presented of an investigation concerning high-temperature heat exchangers for a closed-cycle MHD plant working on an inert gas. A comparative study of different types of heat exchangers was carried out for two MHD power plants with the capacity of 25 MW each, one using helium and another argon as its working medium. Heat exchangers with intermediate heat carriers of the regenerative and recuperative type were considered and the recuperative type was chosen. Results of tests of different materials are presented. An analytical investigation for selection of a heat exchanger with optimal parameters are given. Heat transfer surface is determined and the design of a heat exchanger is described and illustrated by diagrams. 17 refs.

56993 Measurement of excess oxidizer ratio in MHD generator combustion products. Pinkhasik, M.S.; Mironov, V.D.; Zakharko, Yu.A.; Plavinskii, A.I. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 12, 10-14(Dec 1976). (In Russian).

The possibility of measuring the excess oxidizer ratio in the α/less than equivalent to/1 region in the combustion products of an MHD generator is considered. A simple relation between the emf of the electrochemical sensor and the excess oxidizer ratio at $alpha$<1, with oxygen enrichment of the oxidizer up to 40% and the presence of an ionizing additive, is derived. The method of experimental verification of three types of models and possible diagrams of connection of electrochemical sensors, developed and tested on the U-25 plant with an MHD generator, are described. Test results are presented and a comparative characteristic is given.

56994 Experimental investigation of vibration regimes of combustion in combustion chambers of the U-25 plant. Balashov, N.A.; Dreizin, L.Z.; Miyaev, N.A.; Perekal'skii, A.F.; Pinkhasik, M.S.; Privalov, N.P.; Sukhov, V.N. (Inst of High Tem, Acad of Sci of the USSR). *Teploenergetika (Moscow);* No. 12, 14-17(Dec 1976).

The investigation was carried out on two types of combustion chambers in a series of start-ups of the U-25 plant both operating with an MHD generator with the presence of a magnetic field and with a gas duct/channel initiator without a magnetic field. Piezoelectric sensors were installed in combustion chamber walls and in the fuel supply system. It is shown that, by varying the character of flow in slots (slot geometry) and arranging combustion in wakes (installation of baffles), it is possible to ensure stability of the combustion process so that the amplitude of pressure pulsation does not exceed 5% of mean pressure within the combustion chamber.

56995 Investigation of cathode spots in the presence of slag films on open-cycle MHD-generator electrodes. Zalkind, V.I.; Kirillov, V.V.; Markina, A.P. *Zh. Prikl. Mekh. Tekh. Fiz.;* No. 4, 29-32(1976). (In Russian).

The main characteristics of the behavior of cathode spots on the electrodes of an open-cycle coal-fired MHD-generator are investigated. The experiments carried out in the channel of the large U-02 MHD generator, 600 mm long, 180 mm wide, 90 mm high, are described. High-speed photography was used to study cathode spot behavior. It is found that active participation of slag films in the cathode spot arcing process causes a decline in voltage drops at the electrodes and thus should reduce the erosion of the cathode. Chemical erosion, however, may increase considerably. 8 refs.

DUCT ENGINEERING AND FLUID DYNAMICS

56996 (FE—2341-1) High magnetic field MHD generator program. Quarterly report, October—December 1976. Eustis, R.H.; Kruger, C.H.; Mitchner, M.; Self, S.A.; Koester, J.K. (Stanford Univ., Calif. (USA). High Temperature Gasdynamics Lab.). Jan 1977. Contract EX-76-C-01-2341. 24p. Dep. NTIS, PC A02/MF A01.

Technical and programmatic progress on research related to high magnetic field effects in MHD generators is reported herein. An experiment to determine the possible growth of pressure fluctuations showed a three-fold increase in fluctuation amplitude at 2.4 tesla magnetic field compared to zero field. Experiments with a newly developed forward scatter laser anemometer were successful in measuring the velocity and turbulent intensity in the MHD combustor free jet. Refinements in the temperature measuring technique by line reversal resulted in spatial resolution of 300 microns at distances greater than 500 microns from the surface. Experiments related to the Hall field breakdown problem delineated further the character of "fast" and "slow" breakdown corresponding to the origin of the breakdown in the plasma or the insulator. Preliminary work on the disk generator for testing in the six tesla magnet is described.

56997 (N—77—16445) Velocity and temperature distributions of coal-slag layers on magnetohydrodynamic generator walls. Pian, C.C.P.; Smith, J.M. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Jan 1977. 19p. (NASA-TN-D—8396; E—8929). NTIS PC A02/MF A01.

Approximate analytical expressions are derived for the velocity and temperature distributions in steady state coal slag deposits flowing over MHD generator walls. Effects of slag condensation and Joule heating are included in the analysis. The transport conditions and the slag temperature at the slag-gas interface are taken to be known parameters in the formulation. They are assumed to have been predetermined either experimentally or from the slag properties and the gas dynamic calculations of the free stream flow. The analysis assumes a power law velocity profile for the slag and accounts for the coupling between the energy and momentum conservation equations. Comparisons are made with the more exact numerical solutions to verify the accuracy of the results.

56998 Some results of investigation of pressure pulsations in a condensing injector. Shpil'rain, E.E.; Gandel'sman, A.F.; Sevast'yanov, A.P.; An, I.V.; Vainshtein, S.I.; Ryabtsev, V.A.; Rozenglat, M.Sh.; Frish, A.E. (L'vov Polytech Inst, Ukr SSR). *Teploenergetika (Moscow);* No. 12, 7-10(Dec 1976). (In Russian).

Condensing injectors find use in new fields of technology and at the present time are one of the possible variants of boosting devices in the loop of a liquid-metal MHD generator. Methods of the theory of random functions, and in particular spectrum analysis, are employed to study pulsations of pressure and other parameters in two-phase bubble-structured flow. Only frequency characteristics of pressure pulsations are considered. An experiment is described wich was carried out on a water and steam model of injector. 12 refs.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 55972

FUEL CELLS

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 57000

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 56897

MATERIALS, COMPONENTS, AND AUXILIARIES

56999 (N—77—16444) Investigation of acid-resistant electrocatalysts for fuel cells. Meier, H.U.; Tschirwitz, U.; Zimmerhackl, E.; Albrecht, W. (Bundesministerium der Verteidigung, Bonn (Germany, F.R.). Abt. Wehrtechnik). Jan 1977. Translated from German Report, Bmvg-Fbwt-76-6. (NASA-TT-F—17367). 83p. NTIS PC A04/MF A01.

The use of polymeric metal phthalocyanines, chiefly those of iron and cobalt, as electrocatalysts is discussed. Their production and various properties (conductivity, catalase effect, acid resistance, electrocatalytic activity for reduction of oxygen in sulfuric acid) are considered. Fe-polyphthalocyanines showed especially high electrocatalytic activity. A model is suggested for the reaction mechanism to explain this finding.

ELECTROCHEMISTRY, MASS TRANSFER, AND THERMODYNAMICS

57000 (ERDA/NASA/1002—77/10) Factors affecting the open-circuit voltage and electrode kinetics of some iron/titanium redox flow cells. Reid, M.A.; Gahn, R.F. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1977. Contract EC-76-A-31-1002. 17p. (NASA-TM-X—73669; CONF-770531—8). Dep. NTIS, PC A02/MF A01.

From Meeting of the Electrochemical Society; Philadelphia, Pennsylvania, United States of America (USA) (8 May 1977).

Performance of the iron-titanium redox flow cell was studied as a function of acid concentration. Anion permeable membranes separated the compartments. Electrodes were graphite cloth. Current densities ranged up to 25 mA/cm^2. Open-circuit and load voltages decreased as the acidity was increased on the iron side as predicted. On the titanium side, open-circuit voltages decreased as the acidity was increased in agreement with theory, but load voltages increased due to decreased polarization with increasing acidity. High acidity on the titanium side coupled with low acidity on the iron side gives the best load voltage, but such cells show voltage losses as they are repeatedly cycled. Analyse show that the bulk of the voltage losses are due to diffusion of acid through the membrane. No membrane tested so far will maintain differences in acidity. Chelating agents show some promise in reducing polarization at the Ti electrode and thus improving energy efficiency.

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 56948, 56982

57001 (NP—21852) **Planner's handbook on energy (with emphasis on residential uses).** (Florida State Energy Office, Tallahassee (USA)). 28 Nov 1975. 270p. State Energy Office, Tallahassee, FL $4.50.

This handbook was written to provide planners in the Division of State Planning for the state of Florida with specific data concerning residential energy consumption and general background data on the subject of energy. The information presented is divided into four categories: energy consumption for residential purposes, i.e., in and around the home and for auto travel to and from the home; pollution, waste and land use with emphasis on their relationships to energy consumption in the residential sector; the interrelationship between energy and the economy, society, growth, and the environment; and a presentation of energy statistics which are an indication of future aspects of the energy situation. (LCL)

BUILDINGS

REFER ALSO TO CITATION(S) 56001, 56233, 56234, 56235, 56304, 56910, 56925, 56942, 56984, 57031

57002 (ANL—77-39) **HYCSOS: a chemical heat pump and energy system based on metal hydrides.** Gruen, D.M.; Sheft, I.; Lamich, G.; Mendelsohn, M. (Argonne National Lab., Ill. (USA)). Jun 1977. Contract W-31-109-ENG-38. 45p. Dep. NTIS, PC A03/MF A01.

The HYCSOS chemical heat pump and energy conversion system based on metal hydrides are described. The HYCSOS thermal energy storage and recovery modes; the chemical heat pump heating and cooling modes as well as the energy conversion mode are discussed in detail with the aid of heat transfer fluid and hydrogen flow diagrams. The thermodynamic efficiencies of the two metal hydride system are calculated for the heat pump and conversion modes. Design and construction features of a demonstration test facility which utilizes four stainless steel tanks holding 10 lbs. each of either $LaNi_5$ or $CaNi_5$ are given. The operation, instrumentation and control of the system is detailed with the aid of photographs, drawings and a system layout diagram. Initial operation of the system has shown that 33 moles of hydrogen can be transferred from $CaNi_5$ at approximately 100°C to $LaNi_5$ at approximately 40°C and recovered from $LaNi_5$ at approximately 8°C to reform $CaNi_5H_4$ at 40°C with cycle times approaching 2 minutes for 50 percent hydrogen transfer. The relevant data pertaining to these experiments are given in graphs and tables. The next phase of operations will be done on the fully insulated system to establish a firmer data base, obtain power balances and determine optimum operating parameters. In order to achieve these goals in a reasonable time frame, a data display and handling system is required. A materials development program is being carried out concurrently with HYCSOS operations. Significant progress is being made in the development of new, more cost effective alloy systems displaying superior properties for heat pump action.

57003 (NP—22267) **Detecting structural heat losses with mobile infrared thermography. Part III. Survey of USA CRREL.** Munis, R.H.; Berger, R.H.; Marshall, S.J.; Bush, M.A. (Cold Regions Research and Engineering Lab., Hanover, N.H. (USA)). Dec 1975. 9p. Regions Research and Engineering Lab., Hanover, NH.

During the winter of 1973-74 a mobile infrared thermography system was used to survey the USACRREL building at Hanover, New Hampshire. Excessive heat losses at several locations around the building are described. The need to carefully monitor meteorological conditions before starting a survey of a building exterior to determine if solar radiation decay from the building surface might interfere with thermographic analysis by masking the heat emanating from within the building is discussed.

57004 (PB—264904) **Bibliography on available computer programs in the general area of heating, refrigerating, air conditioning and ventilating. Research project.** Cuba, J.F.; Crall, G.C.P. (Battelle Columbus Labs., Ohio (USA)). Oct 1975. 114p. (ASHRAE/GRP—153). NTIS PC A06/MF A01.

Prepared by Battelle Columbus Labs., Ohio.

The descriptions of computer programs included in this bibliography were developed to inform potential program users of the programs available, what the programs do, and who to contact for more information. The computer programs described are arranged alphabetically by sections according to the type of computation being performed: (1) Heating and/or Cooling Load Calculation Programs containing the calculation of heating and/or cooling loads for a building or zone; (2) Energy Analysis Programs concerning the estimation of the annual energy consumption of buildings; (3) Duct Design Programs used to assist in the areas of duct sizing, cost estimating, and sound analysis; (4) Piping Design Programs classified either as pipe sizing programs or as pipe flexibility programs; (5) Equipment Selection Programs containing the selection of HVACR equipment; and (6) Solar Programs that include collector area and performance characteristics, storage capacity, building load, and weather data to predict the performance of the solar heating and/or cooling system.

57005 **Heat pumps: worldwide.** *ASHRAE J.;* **19**: No. 7, 34(Jul 1977).

The use of heat pumps in Australia, the German Federal Republic, Japan and Sweden and growth in heat pump applications for residential, commercial, and industrial buildings is reviewed briefly. (LCL)

57006 **Scientific and technical problems of district heating in the tenth five-year plan period.** Sokolov, E.Ya. (All-Union Inst of Heat Eng, USSR). *Teploenergetika (Moscow);* No. 11, 2-5(Nov 1976). (In Russian).

The energy effect of district heating in the Ninth FYP period (1971-1975) is shown and the main scientific and technical problems of the further development of district heating in the 1976-1980 period are considered. In 1975 the electric capacity of district heating turbines installed at power plants in the USSR amounted to 59 NkW and the annual heat deliveries from heat-and-power plants amounted to more than 3.8 GJ (900 million Gcal) which is about 40% of the total consumption of low and medium heat capacity in the USSR. The total annual heat deliveries from large centralized heat supply plants, i.e. from heat-and-power plants and large industrial and district heating boilers, amounted to about 7.1 billion GJ (1.7 billion Gcal), i.e. about 75% of the total heat consumption in the country.

57007 **Some ways to improve the efficiency of district heating in the tenth five-year plan period.** Shimsman, S.E. (Mosenergo, USSR). *Teploenergetika (Moscow);* No. 11, 18-20(Nov 1976). (In Russian).

It is shown that, in conditions when the rate of development of district heating lags behind the rate of increase of heat consumption, it is expedient to develop thermal capacity of a district heating system by installing additional peaking boilers in the system.

57008 **Method of calculation of the optimum coefficient of industrial district steam heating.** Aminov, R.Z.; Dolgina, V.D. (Saratov Polytech Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* 82-86(Nov 1976). (In Russian).

A fairly simple method of determination of the optimal proportion of production steam set aside from controlled bleedings at heat and power plants for industrial heating purposes is worked out. Calculations show that the coefficient of industrial steam heating supply depends to a substantial extent on the production steam bleeding pressure and on the closing costs of fuel. It declines with a rise in pressure and with a decrease in fuel costs. It is shown that taking into account the industrial and space heating steam bleeding from PT-type turbines at different times of the year results in a significant decrease in the values of coefficient values.

57009 **Problems of improving the methods of design of heat supply systems.** Savin, V.I.; Khrilev, L.S.; Sokolova, V.Yu.; Il'kevich, Z.A.; Novikova, L.P. (SEI, Acad of Sci of the USSR). *Teploenergetika (Moscow);* No. 11, 9-17(Nov 1976). (In Russian).

Problems of further improvement of methods of design of heat supply systems by using computers are considered. Optimization problems are analyzed in depth. It is concluded that, in designing heat supply systems, the basic initial data must be set not in a determined form, but by a range of possible changes established for each of the initial indices as a result of a careful analysis of available experience and local conditions. Optimization should be considered for a period of 15 y divided into 5-y stages.

57010 **Computer-aided hydraulic design of a ramified district heating network.** Zinger, N.M.; Andreeva, K.S.; Fedorov, E.M.; Oshchepkova, T.B. (Heat Eng Inst, Acad of Sci of the USSR). *Teploenergetika (Moscow);* No. 11, 20-24(Nov 1976). (In Russian).

Hydraulic design of ramified hot water supply systems of both closed and open district heating systems is considered. Computer-aided design using an M-222 computer, an algorithm and a design program developed by the VTI (All-Union thermal Engineering Institute) and the SEI (Siberian Institute of Power Engineering) of the Siberian Branch of the USSR Academy of Sciences is presented.

57011 **Main lines of improvement of construction of district heating systems.** Skvortsov, A.A. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 11, 24-27(Nov 1976). (In Russian).

Some information about construction methods and results of operation of district heating systems is presented. Shortcomings are pointed out and the ways how to eliminate them are indicated.

Improvements aiming at ensuring more reliable operation of district heating networks and at reducing construction costs are discussed. Some examples of Soviet and foreign district heating pipeline constructions, their advantages and dissadvantages are given.

57012 Design of energy-integrated building subsystems and their evaluation. Meckler, G. *IF (Ind. Forum);* 7: No. 2-3, 17-26(1976).

Man-machine combinations produce a lot of heat; buildings are generally lighter and equipped with independent over-sized subsystems that are energy-wasteful. It is necessary to analyze the utilization of energy after it has been brought into the building. An energy-efficient building requires that the subsystems be integrated, both theoretically and practically. This integration can be static (i.e., physically integrated) or dynamic (i.e., functionally integrated). Dealing with heating and cooling loads should be based on the first and second laws of thermodynamics, particularly removing heat at the highest possible temperature level for cooling and adding heat at the lowest possible temperature of heating. The concept of Second Law Efficiency indicates how efficiently a specific heating or cooling task is performed by given equipment. Using double induction mixing boxes and water-cooled luminaires and sun-louvers, integrated subsystems have been designed which save up to 50 percent in energy demand and 40 percent in operating costs.

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 56117, 56946

57013 (CONF-770225—1) **Household fuel demand analysis.** Cohn, S.; Hirst, E.; Jackson, J. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

From 4. annual meeting of the Midsouth Academy of Economists; Memphis, Tennessee, United States of America (USA) (10 Feb 1977).

This study develops econometric models of residential demands for electricity, natural gas, and petroleum products. Fuel demands per household are estimated as functions of fuel prices, per capita income, heating degree days, and mean July temperature. Cross-sectional models are developed using a large data base containing observations for each state and year from 1951 through 1974. Long-run own-price elasticities for all three fuels are greater than unity with natural gas showing the greatest sensitivity to own-price changes. Cross-price elasticities are all less than unity except for the elasticity of demand for oil with respect to the price of gas (which is even larger than the own-price elasticity of demand for oil). The models show considerable stabiity with respect to own-price elasticities but much instability with respect to the cross-price and income elasticities.

57014 (ORNL/CON—10) **Energy and cost analysis of residential water heaters.** Hoskins, R.A.; Hirst, E. (Oak Ridge National Lab., Tenn. (USA)). Jun 1977. Contract W-7405-ENG-26. 51p. Dep. NTIS, PC A04/MF A01.

A detailed computer model is developed to calculate energy flows for residential electric and gas water heaters. Model equations are derived from applications of the first law of thermodynamics, analysis of manufacturers' literature, and related studies. The model is used to evaluate the energy (and associated initial cost) impacts of alternative designs to reduce water heater fuel use. Model results show that the largest heat loss in an electric water heater is conduction through jacket walls (14% of energy input). An additional 5% is lost through the distribution pipe for a 7.6 m (25 ft) long pipe. The remaining 81% of energy input is used to heat water. In a gas water heater, conduction losses through jacket and distribution pipe are 12% and 3%, respectively; and 33% is lost up the flue (due to main burner and pilot light operation). Only 52% of energy input to a gas water heater is used to heat water. Several energy-saving design changes are examined using the energy model. Changes for both electric and gas water heaters are: increase jacket insulation thickness, reduce jacket insulation thermal conductivity, reduce thermostat setting, and add insulation to the distribution line. Application of all these changes to an electric water heater would reduce electricity use 17% and increase initial cost 27%. Additional changes examined for gas water heaters are: reduce pilot rate, eliminate pilot and add electric ignitor and flue closure, and reduce excess air for combustion by increasing flue baffling. Implementing all these changes to a gas water heater (except addition of electric ignitor) would reduce gas use 27% and increase initial cost 26%. These results show that there are large opportunities for reducing water heater energy use with only small initial cost increases.

57015 (PB—264759) **The costs of cold weather and the conservation of residential heating gas. Staff report.** Seidel, M.R. (Federal Power Commission, Washington, D.C. (USA). Office of Policy Analysis). 28 Feb 1977. 34p. NTIS PC A03/MF A01.

This report analyzes the impact of this year's abnormally cold weather on natural gas consumption by residences, and estimates the long-run conservation investments that cost-effective in each state.

57016 Energy conservation in the production of hot water. Miles, A.J. (British Gas Corp., London). *Gas Eng. Manage.;* 17: No. 6, 210-216(Jun 1977).

When considering the provision of hot water only, the instantaneous water heater and multipoint offer the simplest and most efficient way of producting hot water, but storage hot water systems can achieve efficiencies of 49% when used according to a realistic pattern of draw-off and with further improvements, this figure might be raised to 60%. Unless an effectively used time clock or a good control system is employed, the efficiency of a hot water storage system will be depressed. Adequate insulation and the use of low thermal capacity boilers are also highly desirable. The relative hot water efficiencies for gas and electricity are potentially in the ratio of approximately 75:100 (or 71:27 in terms of primary energy). In practice, the gas hot water storage system suffers heat losses in transferring heat from the boiler to the cylinder which do not occur in the corresponding electric system.

57017 Direct cooling refrigerator-freezers. Hayashi, Y. (Tokyo Shibaura Electr Co, Jpn). *Toshiba Rev., Int. Ed.;* No. 106, 34-37(1976).

Two-door refrigerator-freezers having separate refrigerator and freezer cabinets are divided into two general categories: natural cooling air convection system (direct cooling) and forced convection (fan cooling). In the direct cooling system, the refrigerating compartment and the freezing compartment are each equipped with a separate evaporator and the cooling is effected by natural convection. As the freezing compartment is surrounded by evaporator plates in four directions, food stored in the freezer can directly contact them. This makes freezing time shorter. Within the refrigerating compartment, the evaporator is defrosted every off-cycle. The moisture generated during defrost maintains humidity within the refrigerating compartment, preventing food from drying up. Energy consumption is smaller than that of the fan cooling system. The temperature with the freezing comparment can always be maintained constant. In the fan cooling system, defrosting is accomplished several times per day with the temperature within the refrigerator cabinet increases each time.

OFFICE BUILDINGS

57018 Reductions of the maximum combustion pressure of high-speed diesel engines with high supercharging. Baikov, A.B.; Sidorov, V.I. *Energomashinostroenie;* No. 8, 5-6(1976). (In Russian).

Problems of improving the working process of high-speed diesels in order to ensure the possibility of increasing the pressure of supercharging and the mean effective pressure of the cycle without an increase in the maximum pressure of combustion are considered.

57019 Principles of setting up automated rigs to test diesel engines in conditions close to the operational ones. Levin, M.I.; Petrov, A.S. *Energomashinostroenie;* No. 8, 6-8(1976). (In Russian).

Fundamental problems of formation of test programs are considered and the structural diagram of an appropriate test rig is presented.

57020 Evaluation of the limit state of a cylinder and piston group of diesel engines. Aleksandrov, A.M.; Zalevskii, V.N. *Energomashinostroenie;* No. 8, 8-10(1976).

A method of establishing the limit state of a diesel cylinder and piston group according to the maximum permissible parameters depending on the wear of parts and characterizing the loss of service properties of the diesel engine is set forth. This method makes it possible to determine the moment of occurrence of the limit state of the cylinder and piston group without having to take the engine apart, relying on a selected boundary criterion of the limit state and a limiting parameter value.

57021 Results of investigation of a new combustion chamber. Semenov, B.N.; Karataev, A.P. (Zavlin, M.Ya.). *Energomashinostroenie;* No. 8, 32-33(1976). (In Russian).

A number of variants of diesel engine combustion chambers contained in pistons and involving volumetric film mixture formation are investigated. Use of such chambers permits attainment of an effective working process with different fuels and, at the same time, considerable reduction of the thermal stress intensity on the nozzle tip of the atomizer and on the cylinder head area between valves.

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 56946

57022 (CONS/2103—6) **European waste-to-energy systems. An overview.** (Resource Planning Associates, Inc., Washington, D.C. (USA); Resource Planning Associates, Inc., Paris (France)). Jun

1977. Contract EX-76-C-01-2103. 62p. Dep. NTIS, PC A04/MF A01.

The recovery of energy through the combustion of municipal solid waste is a well-established technique for conserving energy. Combustion units can produce electricity; hot water for domestic use; and steam for district heating, industrial processes, or the drying of sewage sludge. There are fewer than 20 such waste-to-energy systems in the United States. In Western Europe, however, 243 combustion units are currently recovering energy from municipal solid waste. The oldest of these facilities went into service before World War II. Some key facts about Western European countries and their waste-to-energy units are presented. The items discussed include: some common features of the Western European systems; the combustion techniques available; the end uses to which the recovered energy is put; and the economics of the systems. A tabulation of the systems currently operating or under construction in Western Europe is included. (LCL)

TRANSPORTATION

REFER ALSO TO CITATION(S) 56952

57023 Ton-mile, does it properly measure transportation output. Flott, A.C.; Batts, L.R.; Roth, R.D. Washington, DC; American Trucking Associations, Inc. (1975). 12p.

Our national transportation policies have been hampered for too long by faulty analyses based upon the inappropriate use of ton-miles. The types of fallacious conclusions being drawn from such analyses must be exposed. More importantly, a realistic method or methods of measuring transportation which will permit meaningful comparisons of different kinds of transportation outputs must be developed. The need is urgent. We, therefore, urge that the Transportation Research Board address itself to this problem on a priority basis and that it appoint a committee or subcommittee representative of governmental agencies, carrier representatives, and transportation engineers and economists to study this problem and submit a report on its findings at its earliest convenience.

AIR AND AEROSPACE

57024 (PB—265387) **Fuel economy. Subject bibliography.** Flynn, L.; Edmonds, A. (National Highway Traffic Safety Administration, Washington, D.C. (USA). Technical Services Div.). Jan 1977. 144p. (SB—11; DOT-HS—802-147). NTIS PC A07/MF A01.

This bibliography represents literature acquired since the establishment of the National Highway Traffic Safety Administration (NHTSA) in 1967, as related to fuel economy and the energy crisis in the transportation field. It is comprised of NHTSA contract reports, reports of other organizations concerned with highway safety, and articles from periodicals in related fields. A listing of Congressional documents includes House and Senate hearings, reports and acts in the energy field.

RAILWAY

57025 (PB—264916) **Western coal transportation: unit trains or slurry pipelines. Final report.** Sargent, A. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Urban Studies and Planning). Aug 1976. Contract DOT-OS-30104. 93p. NTIS PC A05/MF A01.

This report focuses on one commodity, coal, and two modes of transportation, railroads and slurry pipelines. The competition between railroads and slurry pipelines for the transportation of coal mined in the West is examined in depth, as is the impact that institutional and regulatory constraints may have on the competition.

57026 Articulated trams '2000 series' of the Zurich municipal transport authority. Baechler, U. *Brown Boveri Rev.;* 63: No. 12, 717-723(Dec 1976).

From 1976 onward, the Zurich Municipal Transport Authority is putting a total of 60 articulated trams of the series 2001/2301 'Tram 2000' into operation. These vehicles, conceived as 'all-electric' vehicles, are equipped with electronic choppers and electronically controlled spring-loaded brakes. The author provides a concise but comprehensive description of the electrical part of the vehicle.

57027 Experimental 3000 v d.c. locomotive of the Italian state railways with chopper control. Cogliati, A.; Framba, B.; Lanzavechia, L.; Mazzia, M. *Brown Boveri Rev.;* 63: No. 12, 737-743(Dec 1976).

The electrical equipment of an 84-ton total weight locomotive is described. The locomotive is equipped with four traction motors with exclusively external excitation. Each traction motor has its own group of choppers comprising three identical units. The pulses of the three units are mutually displaced by 120°. In addition to that, the four choppers groups are mutually phase-shifted by 90°, so that a 12-pulse reactive effect is produced ahead of the line filter. The continuous adjustment of traction motor voltage and current permits simple drive control.

57028 Bo'bo' motor-coaches for the Ferrocarriles Guadarrama in Spain. Snoeckx, C. *Brown Boveri Rev.;* 63: No. 12, 754-757(Dec 1976).

The electrical equipment of adhesion motor-coaches operating on the secondary line of the Guadarrama regional railway is described. To simplify the electrical equipment only one circuit arrangement is used during motoring and braking. Two traction motors are permanently connected in series and two groups of motors are connected in parallel. For the traction motor fields are cross-connected and pre-excited by the battery. This circuit also permits automatic control of high acceleration starts.

57029 Line fault detectors for direct current railways. Rohr, A. *Brown Boveri Rev.;* 63: No. 11, 678-681(Nov 1976).

An increase in the density of traffic on direct current railways has resulted in their consuming more power. It is necessary therefore to update existing supply systems and construct additional new systems. With d.c. railways it is usual to increase the capacity of the rectifier systems, to build new transformer substations and to raise the values at which the tripping devices of the d.c. circuit-breakers operate. However, since these values must be above the maximum operating current peaks it can happen that at some distance from the feed point, dead short circuits between rails and overhead lines can no longer be detected since the short-circuit current is below the operating value of the tripping device.

LAND AND ROADWAY

57030 (PB—265369) **Passenger car fuel conservation. Final report.** Claffey, P.J. (Federal Highway Administration, Washington, D.C. (USA)). Jul 1976. Contract DOT-FH-11-8490. 244p. NTIS PC A11/MF A01.

Detailed information on the way passenger car fuel consumption is affected by how people drive and by the care taken to keep car engines and tires in proper running order was sought through highway test operations. Test operations included: (1) measurement of the fuel consumption of a sample of 93 drivers for operation under specific sets of urban driving conditions, (2) measurement of the fuel consumption of a sample of 22 passenger cars both for operation before and after a major tune-up, (3) measurement of the fuel consumption of a single passenger car for both low and high ranges of acceleration rates and for stop cycles, stop-cycle frequencies, and for various road design details, and (4) measurement of the fuel consumption of a sample of 18 passenger cars for a given tire inflation pressure and for a pressure equal to 80 percent of the given tire inflation pressure. All fuel consumption measurements were made with a fuelmeter capable of measuring fuel consumption to the nearest 1/1,000th of a gallon.

PIPELINE

REFER ALSO TO CITATION(S) 57025

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 56926, 56927, 56928, 56929, 56943

ENERGY SOURCES

57031 Some aspects of natural gas conservation. Proffitt, R. (British Gas Corp., London). *Gas Eng. Manage.;* 17: No. 6, 180-194(Jun 1977).

It is shown how the energy supply and utilisation situation has changed over the years, necessitating the urgent action for fuel conservation. Figures taken from official sources underline the reasons in addition to fuel prices why the situation has caused the Government to embark on an extremely expensive publicity campaign 'Save It.' Combustion of natural gas is considered, and a flue loss chart is developed. This flue loss chart is simple to use, showing at a glance the thermal efficiency of plant from simple flue gas information. British Gas is making a large and valuable contribution to natural gas conservation in many directions such as leakage control on mains, technical consultancy service, education of customers in fuel utilisation and with developments for industrial utilisation (self-recuperative burner, rapid metal heaters, etc.). In practical terms, items of plant can be utilised more efficiently and care can be taken in planning production. The use of new devices, i.e. thermal wheels and heat pipes, provides new tools to help the fuel engineer conserve energy. (DLC)

MATERIALS

REFER ALSO TO CITATION(S) 56920, 56931, 56933, 57032

57032 (COO—2390-15) **Needs and opportunities for ceramic science and technology.** Kingery, W.D. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Materials Science and Engineering). 1976. Contract EY-76-S-02-2390. 12p. (CONF-7605158—1). Dep. NTIS, PC A02/MF A01.

From International meeting on modern ceramic technology; Rimini, Italy (26 May 1976).

There clearly seems to be a consensus developing that technological requirements, including ceramics, will be sought in the next few decades with regard to (1) substituting common and readily available materials for rarer and therefore diminishing resources, (2) making strong efforts to either conserve energy or develop new sources of energy, (3) protecting the environment, and (4) providing opportunities for more worker satisfaction. An attempt is made to relate these objectives to needs and opportunities for ceramics. The following considerations are discussed in reference to the ceramic industry: labor-capital requirements, materials resource requirements, energy requirements, environmental requirements, fabrication requirements, and new product requirements. (MCW)

57033 **Complex utilization of raw materials and materials by chemical industry in conditions of automated norm-setting system of the azerbaijan republic.** Mamedov, G.Kh. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 103-106(1976). (In Russian).

Complex utilization of raw materials and materials in the chemical industry makes it possible to utilize cheap raw materials, reduce the consumption of materials and energy resources per unit of production and to reduce the costs of products. The automated norm-setting system makes it possible to improve complex utilization of raw materials and materials in the chemical industry of the Republic in conditions of an automated production control system; it envisages control over the justification of the normative information at all the levels of planning. Creation of the normative base of the automated norm-setting system is implemented with consideration of the entire complex of requirements arising in accordance with the tastes of automation of production and management control. It helps not only to set the norms for material resources but also to elaborate normative indices for all the working capital assets.

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 55667, 55685, 55686, 55775, 56942

57034 **Electric conductive billet heaters.** Heine, H.G. (Brown Boveri Corp, North Brunswick, NJ). *Iron Steel Eng.;* **54**: No. 2, 38-42(Feb 1977).

In a steel mill billet reheat application, the desired temperature of the billet is around 2200°F. This temperature practically eliminates any indirect heating by means of electric resistance elements, and leaves only the choice of either plasma arc heating, induction heating or direct passage of current through the billet. The latter method is known as conductive heating. If the billet were the heating element, the highest possible efficiency (in the range of 85%) would result. This is the basis for the development of the conductive billet heater. Typical energy consumption/ton of cold steel is approximately 250 KWhr. The conductive billet heater lends itself ideally to a rolling mill application for which it was originally designed.

57035 (PB—264543) **Guidelines for industrial boiler performance improvement. (Boiler adjustment procedures to minimize air pollution and to achieve efficient use of fuel).** McElroy, M.W.; Shore, D.E. (KVB, Inc., Tustin, Calif. (USA)). Jan 1977. Contract EPA-68-02-1074. 107p. (KVB—6001/8300-461). NTIS PC A06/MF A01.

Sponsored in part by Federal Energy Administration, Washington, D.C. Office of Energy Conservation and Environment. See also report dated Oct 1975, PB—248292.

Recommended procedures for improving industrial boiler performance to minimize air pollution and to achieve efficient use of fuel are given. It is intended for use by industrial boiler operators to perform an efficiency and emissions tune-up on boilers firing gas, oil, or coal. Portions of the guidelines are also intended for plant engineers interested in initiating preventive maintenance and boiler efficiency monitoring practices to maintain peak boiler operating efficiency. Background material on nitrogen oxides reduction techniques, the cost of combustion modifications, methods and equipment for efficiency improvement, and a discussion of combustion generated air pollutants are included.

57036 (TREE—1135) **Energy oriented study of fluidized bed systems.** Cox, N.D.; Richardson, A.S.; Jensen, W.P. (EG and G Idaho, Inc., Idaho Falls (USA)). May 1977. Contract EY-76-C-07-1570. 34p. Dep. NTIS, PC A03/MF A01.

This study was performed to obtain data for an estimate of the current and anticipated energy demand for the operation of industrial fluidized bed systems. The information sources used were technical papers and texts on the subject and a survey of manufacturers of equipment used in fluidized bed systems. Four basic functions of fluidized bed systems were identified. Estimates of the throughput for some of the functions were made. Insufficient data were available for making quantitative estimates of the potential for energy conservation. Qualitatively, the manufacturers estimated an average increase in short run (next 5 years) sales volume of 100 percent. Several examples of steps being taken by industry to reduce energy requirements of fluidized bed systems were cited. In addition, research work aimed at substituting fluidized beds for less efficient alternatives was reported.

57037 **Radio frequency textile drying.** *Energy Dig. (London) ;* **6**: No. 1, 26-27(Feb 1977).

A great improvement in product quality and a reduction of over 60 per cent in the cost of drying textile fibres after dyeing has resulted from the installation of a radio frequency dryer in the works of William Smith and Co. Ltd. at Morley, near Leeds. Analysis of alternative drying systems led to the conclusion that a radio frequency dryer offered the best solution. Its selective effect becomes very useful for drying textiles. In a wet mass of textile fibres the wetter areas will heat most and the energy absorbed will diminish with the moisture content until the areas with no free moisture will absorb almost no power. This means that once a fibre reaches its natural regain level it will dry very little more if at all. The machine has a maximum output of 50 kW at 27.12 MHz with a maximum mains loading of 85 kVA. As with any radio frequency dryer, however, the power demand is roughly proportional to the amount of water being removed so that the full mains loading will not always be required. Drying times for typical products can be reduced from 4-12 hours by the old method down to 15-45 minutes with the radio frequency unit.

57038 **Comparison of energy needs between conventional technologies and powder metallurgy.** Bocchini, G.F. (Merisinter, Arzano-Napoli, Italy). *Metall. Ital.;* **68**: No. 11, 521-531, 548(Nov 1976). (In Italian).

Due to the energy crisis, it can be useful to examine the sintered products in order to evaluate possible advantages and single out the lines of action which could improve the energy balance sheet. In this study, the production processes for sponge iron powder and steel bars were examined in order to determine the amount of energy necessary to obtain the unit weights of different materials. The study of sintering furnaces has led to some proposed changes which could substantially reduce energy losses.

57039 **Method of improving operating efficiency of blow fans and exhaust fans of the 0.55-40-1 type.** Postolovskii, S.N.; Margolina, R.V.; Potanina, M.L. *Energomashinostroenie;* No. 8, 41-42(1976). (In Russian).

Recommendations on improving blow and exhaust fans in operating conditions are given.

57040 **Reducing power consumption in olefin plants.** Sohns, D.; Fuge, C. *Linde Rep. Sci. Technol.;* No. 23, 11-18(1976).

Increasing power costs have increased the demand for plants with a high degree of power utilization. It is possible to decrease the power consumption of olefin plants by process improvements, but these frequently involve a greater capital outlay. Improvements in the hot section and of the compression process seem to promise a higher degree of energy conservation than improvements in the separation section, downstream of the feedgas compressor. Detailed process flow charts accompany the discussion. 1 ref.

57041 **Heating bell furnaces with natural gas.** Terekhova, A.I.; Ibatulina, K.A.; Litovchenko, A.P.; Pavlov, I.M.; Osokin, G.F. *Metallurgist (USSR) (Engl. Transl.);* **20**: No. 3-4, 267-269(1976).

The changeover of the bell furnaces of the heat treatment section of the sheet mill to heating with natural gas made it possible to use two-stage combustion of the gas using atmosphere-injection burners and thereby to provide more stable combustion of the fuel without flashbacks and breaking away of the flame in the burner, improve heating and increase the quality of the annealed sheet, increase the service life of the burners, eliminate furnace downtime for cleaning the furnace gas lines with steam and decrease the consumption of fuel by 2.5 kg/ton and of steam by 0.018 Mcal/ton.

57042 **Thermal operation of double-bath steel-smelting furnaces.** Andreev, V.A.; Voitov, A.O.; Gusev, V.F.; Evtifeev, V.I.; Kornfel'd, V.N.; Mal'chenko, T.V.; Minnibaev, R.Sh. *Metallurgist (USSR) (Engl. Transl.);* **20**: No. 3-4, 257-260(1976).

The long-term (more than two years) operation of the heating system developed for the furnace with the movable burners with the effective burner positioned externally (relative to the cold chamber) confirmed the importance of performance indicators using thermotechnical means (utilizing the fuel and heat of the flue gases passing from the hot into the cold chamber to improve the heating of the charge prior to pouring the cake). On heating the furnace with the movable burners, the fuel and oxygen consumption diminished by

1.7 kg/ton and 1.6 m^3/ton, respectively, compared with heating with combined stationary burners.

WASTE HEAT RECOVERY AND UTILIZATION

57043 (PB—264959) **Waste heat management guidebook. Final report.** Kreider, K.G.; McNeil, M.B. (National Bureau of Standards, Washington, D.C. (USA). Office of Energy Conservation). Feb 1977. 176p. (NBS-HB—121). NTIS PC A09/MF A01.

Library of Congress catalog card No. 76-608201.

Sources of waste (i.e., discarded) heat in industrial processes are reviewed, and an overview of off-the-shelf technology available for its use is given. Discussions of waste heat measurement technology and economics are included, as are fourteen case studies of successful industrial waste-heat recovery installations.

57044 **Heat recuperator: improved heat transfer efficiency.** *Ind. Gas (Duluth);* **57**: No. 3, 14-16(Mar 1977).

The recuperator, a modified heat exchanger, extracts energy from higher temperature flue gases and transfers it to the cooler ambient air. The manufacturer of this unit, designed to replace the conventional exhaust stack on direct-fired and radiant tube-fired furnaces, reduced fuel requirements for Ford by 29%. The net effect of recuperation was determined by running identical production cycles, temperatures, and loads in both furnaces.

57045 **Comparison between regenerative and recuperative heat recovery systems in ventilating plants.** Hartmann, C. (Kleinewers Ind-Co, Krefeld, Ger). *Klima Kaelte Ing.;* **5**: No. 2, 47-52(Feb 1977). (In German).

The opportunities of heat recovery in ventilating plants are numerous. The selection of the heat recovery system should be made for every application only after assessment and comparison of investment costs and saving expenditure for energy, taking into consideration the technical conditions. The recovery of energy is calculated and compared for three systems.

57046 **Considerate steelmaking helps cut steel costs.** Brolin, T.; Mathiesen, M.; Ortenblad, B. (R Inst of Technol, Stockholm, Swed). *Tek. Tidskr.;* **107**: No. 3, 20-23(11 Feb 1976). (In Swedish).

It is shown that the energy consumption in iron and steel industry can be reduced by efficient waste heat utilization and by introducing energy-saving reduction processes.

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 56925, 56925

57047 (EPA—600/2-77-048) **State of the art: wastewater management in the beverage industry.** Joyce, M.E.; Scaief, J.F.; Cochrane, M.W.; Dostal, K.A. (Environmental Protection Agency, Corvallis, Oreg. (USA). Industrial Environmental Research Lab.). Feb 1977. 124p. NTIS.

The water pollution impact caused by the wastes from the beverage industry and the methods available to combat the associated problems were studied. The size of each industry is discussed along with production processes, wastewater sources and effluent characteristics. Wastewater management techniques are described in terms of in-plant recycling, by-product recovery and end-of-pipe treatment along with the economics of treatment. The malt liquor, malting, soft drinks and flavoring industries primarily dispose of their effluents in municipal sewers. In-plant recycling and by-product recovery techniques have been developed in these industries to reduce their raw waste load. The wine and brandy and distilled spirits industries in many cases must treat their own effluents so they have developed wastewater management systems including industry-owned treatment plants that yield good effluents. The technology to adequately treat rum distillery wastewater has not been demonstrated. The information basis for this study was a literature search, an effluent guidelines report done for EPA, limited site visits, personal communications and an unpublished report conducted for EPA that included questionaire surveys of the industries.

57048 **Thermodynamic estimation of the minimum concentration attainable in a flow-through porous electrode reactor.** Trainham, J.A.; Newman, J. (Univ. of California, Berkeley). *J. Appl. Electrochem.;* **7**: No. 4, 287-297(Jul 1977).

The minimum concentration attainable in a porous flow-through reactor is estimated by applying the thermodynamics of electrochemical cells with a knowledge of the maximum reactor operating potential. This predicted concentration is the equilibrium wall concentration at the back of the reactor and is qualitatively compared to the experimentally measured minimum average bulk values observed by various authors for the deposition of copper, silver, lead, and mercury, and for the oxidation of ferrous ions. It is suggested that a knowledge of the current versus reactor operating potential will elucidate the lower limits observed for any metal system. In particular, the case of antimony removal is discussed.

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 56925

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

57049 **Centrifugal air precleaner for internal combustion engines.** Fields, G.S. (to Parma Industries, Inc.). US Patent 4,028,076. 7 Jun 1977. Filed date 18 Aug 1975. 6p.

An air precleaner for internal combustion engines having a central conduit for conducting precleaned air to the air intake of the engine is described. A housing is disposed around the central conduit and forms an air intake opening, an arcuate wall spaced radially outwardly from the conduit and substantially concentric therewith for conducting the incoming air stream from the intake opening around the conduit so that any dust in the air stream is collected along the housing wall by centrifugal action, and a dust outlet for discharging dust from the housing at the downstream end of the arcuate wall.

57050 **Intake air heating device for use in internal combustion engine.** Kamada, N.; Hasebe, N. (to Hitachi, Ltd.). US Patent 4,027,642. 7 Jun 1977. Priority date 14 Aug 1974, Japan. 6p.

;The intake air heating device comprises means for guiding flames from a flame holding or baffle cylinder to an intake pipe, the means being attached to one end of the flame baffle cylinder integrally secured to the body proper of the intake air heating device and projecting into the interior of an elbow portion of the intake pipe, or secured to the inner wall of the elbow portion of the intake pipe which faces one end of the flame baffle cylinder so that the intake air heating device may fulfill the inte-air heating function when mounted on the elbow portion of the intake pipe connecting an air cleaner with an engine.

57051 **Calculation of the non-steady gas exchange process in internal combustion engines.** Ryti, M. (0800;421000). *Forsch. Ingenieurwes.;* **42**: No. 6, 201-207(1976). (In German).

In order to enable the use of the same integration procedure for the partial as well as for the ordinary differential equations which together describe the non-steady gas exchange process in internal combustion engines, thpartial equations for the non-steady pipe flow are transformed into ordinary differential equations with the aid of finite difference approximations. Further, the boundary conditions are written in differential form. The rates of change in the boundary conditions are found solving a system of linear algebraic equations. The equations are formulated for the general case of a gas with variable specific heats and variable composition. The method is valid assuming continuous changes of state, discontinuities sas shock waves need a special treatment.

57052 **Determination of the effective depth of hot junction of surface thermocouples when investigating nonsteady heat transfer in an internal combustion engine.** Buryachko, B.P.; Baranov, Yu.E. *Energomashinostroenie;* No. 11, 10-12(1976). (In Russian).

Problems of the methods of application of surface thermocouples to investigate nonsteady heat transfer in inner cylindrical cavity of internal combustion engines are considered. Data are presented on the design of a surface chromel-alumel thermocouple and a method of determination of the effective depth of its hot junction is described.

SPARK-IGNITION

REFER ALSO TO CITATION(S) 57080

57053 (PB—265064) **Fuel economy improvement through diagnostic inspection. Technical report.** Bayler, T.; Eder, L. (National Highway Traffic Safety Administration, Washington, D.C. (USA). Office of State Vehicle Programs). Mar 1977. 16p. NTIS PC A02/MF A01.

The fuel economy benefits of an exhaust emissions inspection and maintenance system is discussed. Standard EPA fuel economy tests were made on each car before and after minimum cost emission repairs. Fuel economy improvements for each size group in simulated urban and highway driving are discussed.

DIESEL

57054 **Development of promising designs of pistons for boosted modifications of diesels of the chn21/21 type.** Bogdanov, B.I.;

Kosyak, A.F.; Nikitin, M.D.; Voronova, T.I.; Sadovskii, A.P. *Energomashinostroenie;* No. 8, 2-4(1976). (In Russian).

Results of theoretical and experimental investigations of different constructions of pistons for engines of the ChN21/21 family with the boosting level of 12 kg/cm^2 and higher are presented.

57055 Calculation of processes in the gas dynamic exchanger for diesel engine supercharging. Budzhenko, A.I.; Ivanov, P.V.; Iovlev, V.I.; Krasovskii, O.G. *Energomashinostroenie;* No. 8, 10-11(1976). (In Russian).

A method of calculation of gas dynamic processes in the ducts of a gas dynamic exchanger used for diesel supercharging is considered. This method permits evaluation of design variants in the course of development and adjustment.

57056 Bridge control of marine diesel propulsion machinery. Eriksson, K. *ASEA (Allm. Sven. Elektr. A. B.) J.;* **49**: No. 5, 119-122(1976).

Description of ASEA's bridge control system for marine diesel propulsion machinery with fixed propeller, built up from units in the new DS-8 digital electronic system. The engine speed and fuel feed control, fuel economy, critical speed, emergency operation, safeguard monitors, reversing and starting, change-over between different operating modes, order communication and monitoring of sensors and actuators are described in greater detail. Finally, servicing, reliability and commissioning are discussed.

57057 Investigation of the effect of the design and number of piston rings on lubricant burn-up waste. Levkin, G.M.; Nikiforov, O.A. *Energomashinostroenie;* No. 8, 15-16(1976). (In Russian).

It is shown that the use of minute (conical) pressure piston rings and box oil piston rings with an expander in the 2Ch10.5/13 diesel engine permits reduction of lubricating oil burn-up losses to 0.45-0.54 g/(eHP/hr).

57058 Effect of cyclic fuel feeding on the length of the period of delay of fuel self-ignition following diesel engine start in high mountain conditions. Viksman, A.S.; Levin, G.Kh.; Koppel', E.I.; Pershin, V.G. *Energomashinostroenie;* No. 8, 42-43(1976). (In Russian).

Results are presented of an investigation of the title problem in conditions of very low barometric pressure.

57059 Relation between effective diesel engine efficiency and its output of nitrogen oxides with spent gases. Smailis, V.I. *Energomashinostroenie;* No. 8, 43-45(1976). (In Russian).

A new method of evaluation of the efficacy of the measures designed to lower the output of nitrogen oxides with spent gases is proposed. It is based on the utilization of the NO/sub x/-eta/sub e/ (concentration of nitrogen oxides -- effective diesel engine efficiency) system of coordinates.

57060 Characteristics of the working cycle of a turbopiston internal combustion engine. Evenko, V.I. *Energomashinostroenie;* No. 10, 20-22(1976). (In Russian).

The working cycle of a turbopiston engine is considered. It combines the properties of cycles of different engine types. The equations obtained permit analysis of the effect of variation of different parameters on the characteristics of the engine cycle and determination of optimal parameter values as well as evaluating the thermodynamic efficiency of different solutions.

57061 Utilization of phase-frequency characteristics in adjusting all-regime centrifugal regulators for experimental determination of their time constants. Muzychuk, F.M. *Energomashinostroenie;* No. 10, 44-45(1976). (In Russian).

Theoretical principles are set forth and experimental data are presented regarding the utilization of phase-frequency characteristics obtained as a result of harmonic actions on the regulator control lever to determine its time constants.

57062 Effect of hydrocarbon groups and fractional fuel compositions on ignition and combustion processes in diesel engines. Gulin, E.I.; Bedrik, B.G.; Lesnikov, A.P. *Energomashinostroenie;* No. 12, 17-19(1976). (In Russian).

Widening of the range of fuels for diesel engines is considered as a method of controlling the working process of the engines. Theoretical foundations of the process of combustion of fuels of narrow and broad fractional and hydrocarbon group composition in a diesel chamber are set forth. Results of an experimental investigation are summarized. It is found that fuels of certain broad fractional and hydrocarbon group compositions surpass standard diesel fuel by their combustion characteristics.

57063 Investigation of the effect of the technical condition indices of internal combustion engines on working process parameters by numerical modeling method. Matveev, V.V.; Usenya, M.F. *Energomashinostroenie;* No. 12, 38-39(1976). (In Russian).

At present, mostly experiments are used to establish the quantitative relations between the indices of the technical condition of an internal combustion engine and the parameters of its working process. The investigation described in this article solves the problem by numerical modeling of the working process, thus reducing the time and costs involved. The numerical modeling method is employed to study the effects of the cylinder lining wear, the fuel feeding angle of lead, the air filter resistance, and the conditions of cooling of walls of the cylinder and piston group of the 8Ch13/14 diesel engine. The modeling is carried out on a Minsk-32 computer. The relations obtained may be used to construct a diagnostic model of the diesel engine.

TURBINE

REFER ALSO TO CITATION(S) 57326

57064 Effect of design parameters of a fuel pump section on the injection process and the diesel engine working process. Sergeev, A.I.; Dolinin, V.N. *Energomashinostroenie;* No. 8, 36-38(1976). (In Russian).

Results are presented of an experimental investigation into the effect of the diameter and velocity of motion of a plunger, given a constant mean volumetric rate of injection, on the parameters of the injection process and diesel engine working process.

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 55706, 56899

57065 (PB—265018) Technical feasibility study of railroad electrification with high voltage (10-50 kV) direct current. Final report, Jan—Jun 1976. Uher, R.A. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Transportation Research Inst.). Sep 1976. Contract DOT-TS-11702. 75p. NTIS PC A04/MF A01.

High-voltage (10 to kV), direct-current (HVDC) power distribution may prove to be an economically and technically attractive option for railroad electrification. There may be potential economic advantages in both wayside installation and operation, and in the propulsion equipment aboard the rolling stock. However, before an economic comparison with ac systems can be completed, the technical feasibility of dc systems must be determined, which was the purpose of this study. This study was directed toward the wayside equipment only. The problem of HVDC rolling stock was not considered. The preliminary analysis in this report shows no technical obstacle to the use of HVDC power distribution systems for application to the wayside portion of railroad electrification. Circuit breakers, which can be applied to these systems, are in various stages of development, and with reasonably directed research can meet the duty requirements. Likewise, rectifiers which can satisfy both current and voltage requirements are within the state of the art.

57066 Energy saving public transport. *Energy Dig. (London) ;* **6**: No. 1, 28-29(Feb 1977).

The extent of the current British Rail Great Northern suburban electrification scheme comprises 111 route km and 365 single track km. The Outer Suburban part of the system uses a 25 kV single-phase overhead system; the Inner Suburban part, which must run in tunnels, is equipped with a 750 V dc third-rail system. The rolling stock consists of Class 312 four-car electric multiple units for the Outer Suburban service from King's Cross to Royston and Class 313 three-car electric multiple units providing the Inner Suburban service between Moorgate and either Hertford North or Welwyn Garden City. The Class 312 cars have a maximum speed of 90 mph, and a maximum acceleration of 0.9 mph/sec. Normal braking is about 1.8 mph/sec, with 2.2 mph/sec for emergency application. The Class 313 units have a maximum speed of 75 mph with rheostatic braking to 12-16 mph, using air-operated disc brakes to effect the final stop. Waste heat from rheostatic braking is used for warming the passenger accomodation. The Class 313 design enables electric current to be collected from either the 25 kV ac. Overhead Line Equipment or from the 750 V dc third rail systems. Changeoever between overhead contact and conductor rail operation is controlled manually by the driver from the operative driving cab. When the 750 V dc system is selected, the vacuum circuit breaker is locked open and the pantograph system physically locked in the down position. Indicator lamps show the system selected. If a train should run on to a live conductor rail section with the overhead contact equipment connected, or vice-versa, a buzzer sounds continuously until all the train equipments are correctly switched to the appropriate system.

57067 Tubular axle induction motor for rail traction. *Energy Dig. (London) ;* **6**: No. 1, 30-31(Feb 1977).

By mounting an induction motor within a large diameter tubular railway axle British Rail Research and Development engineers are working on a drive system for railway vehicles which will overcome many of the disadvantages of the more traditional motors used currently for rail traction applications. Motor designers, me-

chanical engineers and electronics specialists at the railway Technical Centre, Derby, have designed a motor and power control system which eliminates the troublesome commutator and brushgear problems of d.c. series or a.c. commutator motors, removes the need for a gearbox and also provides a very effective braking action. The severe environment which exists within a railway axle dictates that only a rugged a.c. induction motor could be used for the development and an 'inside-out' configuration has been employed, using the axle walls as the rotor revolving around the fixed inner stator. Special power conditioning equipment using thyristor inverters has been designed to provide the variable frequency variable voltage supply necessary to obtain the best torque/speed characteristics from the motor. Four prototype motors of a size which computer studies show would be suitable for powering multiple unit type trains are under construction for testing next year.

57068 Electric mail delivery vans. Crane, D.P. (Office of Fleet Management, Washington, DC). pp 27-33 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

The scope of vehicle management in the U.S. Postal Service is explained, and a brief history of past involvement with electric vehicles is given. Recent performance experience with electrics is reviewed. A number of photographs show a new electric jeep and its battery-related components. 12 figures. (RWR)

57069 Time for reality. Bry, R. (Otis Elevator Co., Cleveland). pp 41-44 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

A brief summary of the social, technical, and economic status of electric-powered vehicles is presented. Although several experimental buses are currently in use, the cost of electric batteries remains an unpopular feature, and development of a suitable battery continues to be the chief R and D problem. However, electrical energy can be derived from a variety of sources, and, although electricity costs may continue to rise, they will rise at a slower rate than petroleum costs. (PMA)

57070 Battery powered mail vans. Johnson, R.M. pp 45-46, 49-52 of In Battery Council International convention: 1975. Chicago; Battery Council International (1975).

From 87. Battery Council International convention; Hollywood, Florida, United States of America (USA) (8 Apr 1975). See CONF-7504129—.

An electric vehicle designed for the U.S. Postal Service is described. 14 figures. (RWR)

FLYWHEEL PROPULSION

57071 Flywheels: energy saving way to go. *Environ. Sci. Technol.;* 10: No. 7, 636-639(Jul 1976).

The goals of the U.S. Energy Research and Development Administration's energy storage activities are conservation of fuel, fuel substitution, and improved environmental quality. A flywheel heat engine hybrid could raise the efficiency of the internal combustion engine from 12% to more than 20%. ERDA grants in fiscal year 1976 include $200,000 to Lear Motor Co. for development of flywheel technology for use in commuter cars, and $125,000 to the Sandia Laboratories to develop the hybrid vehicle. The real advance will be in materials and design, e.g., the development, within 10 years, of composite rotors with energy densities of 60 to 70 W-hr/lb. The feasibility of a flywheel having an energy density of nearly 100 W-hr/lb has been demonstrated in spin tests with a 30 in. flywheel. Various uses of the flywheel, such as on electric cars and in rail rapid transit systems, are discussed and a tabulation of flywheel development projects is presented.

VEHICLE DESIGN FACTORS

57072 (AD-A—037827) Endurance testing of tracked and wheeled vehicles. Final report. (Army Test and Evaluation Command, Aberdeen Proving Ground, Md. (USA)). 9 Sep 1976. 29p. (TOP—2-2-506). NTIS PC A03/MF A01.

Supersedes Rept. Nos. TOP—2-2-506 dated 2 Dec 1971; AD—738119 and TOP—2-2-507 dated 21 Dec 1973, AD—775434.

A method of evaluating the endurance of tracked and wheeled vehicles is described. Mileage or hours of operation over standard test courses, including land and water, for the various types of vehicles, interspersed with vehicle mission tests are prescribed. Loads, towed loads, speeds, maintenance, and inspections are covered, and the use of the tachograph for recording speed, mileage, and operating time is discussed. All types of vehicles, except materials handling equipment, are covered.

57073 (PB—264516) Research safety vehicle program (Phase II) specification review. Volume II. Final technical report, Jul 1975—Nov 1976. Pugliese, S.M. (Calspan Corp., Buffalo, N.Y. (USA)). Feb 1977. Contract DOT-HS-5-01214. 69p. (CALSPAN-ZM—5793-V-2). NTIS PC A04/MF A01.

See also Phase I, Volume 2, PB—246766, and Phase I, Volume 1, PB—246765.

In Phase I of the Research Safety Vehicle Program (RSV), preliminary design and performance specifications were developed for a mid-1980's vehicle that integrates crashworthiness and occupant safety features with material resource conservation, economy, and producibility. Phase II of the program focused on development of the total vehicle design via systems engineering and integration analyses. As part of this effort, it was necessary to continuously review the Phase I recommended performance specification in relation to ongoing design/test activities. This document contains the results of analyses of the Phase I specifications. The RSV is expected to satisfy all of the producibility and safety related specifications, i.e., handling and stability systems, crashworthiness, occupant protection, pedestrian/cyclist protection, etc.

ENGINE SYSTEM

REFER ALSO TO CITATION(S) 57326

57074 (CONF-761028—4) Improving automotive fuel economy with accessory drives. (MS-4171). (Garrett Corp., Phoenix, Ariz. (USA). Airesearch Mfg. Div.). 1976. Contract EY-76-C-03-1095. 22p. Dep. NTIS, PC A02/MF A01.

From ERDA contractor's coordination meeting; Ann Arbor, Michigan, United States of America (USA) (17 Oct 1976).

A description is given of a program to define and evolve an accessory drive system that will minimize engine driven accessory power consumption and significantly improve the fuel economy of a 1979 internal combustion engine passenger automobile. The program was initiated in June 1974, and Phase IV was completed in September 1976, having met all objectives. A reliable and efficient mechanical variable ratio belt drive was selected from a trade study as the optimum drive for development. The drive was installed in a 1975 Mustang II automobile, extensively tested, and demonstrated an overall fuel economy improvement of 4 to 10% depending on driving conditions. The accessory drive also provided improved vehicle performance, reduced emissions, reduced vehicle generated noise, improved accessory life, and a slight weight decrease. The speed control feature of the accessory drive permits resizing of the engine cooling system fan and radiator, use of a smaller alternator, and deletion of the power steering fluid cooler as well as miscellaneous pulleys and brackets. Demonstrated performance and cost analysis have shown that both the manufacturer and consumer will benefit from an OEM installation of an accessory drive system. Study efforts to define more efficient energy usage of automotive accessories is in progress.

57075 (TID—27672) Design and development of a continuously variable ratio transmission for an automotive vehicle. (Orshansky Transmission Corp., New York (USA)). 1976. Contract EY-76-C-03-1165. 21p. Dep. NTIS, PC A02/MF A01.

The status is reported of a program to develop a two-range, hydromechanical, continuously variable automotive transmission. The work described includes: (1) chassis dynamometer and highway tests for fuel economy, in accordance with the Federal Driving Cycle; (2) acoustical improvements in hydraulic units and gearing; and (3) driveability improvements. Test results are compared with those for a torque converter. (PMA)

57076 Fluid flow control valve for gas turbine engine fuel control system. Smith, T.S. (to Lucas Industries Ltd.). US Patent 4,019,317. 26 Apr 1977. Priority date 23 Oct 1974, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

A fluid flow control valve includes a body having an inlet and two outlets. A metering control element is slidable in the body to regulate flow through one of the outlets. A combined spill and throttle control element is slidable within the metering element so as simultaneously to control metered flow between the inlet and the one outlet, and spill flow between the inlet and the other outlet. Both of the control elements are responsive to respective servo pressure signals.

57077 Apparatus for generating high-pressure gas. Oda, N.; Yoshida, T.; Nakanishi, T.; Yoshikawa, K. (to Hitachi Shipbuilding and Engineering Co., Ltd.). US Patent 4,019,319. 26 Apr 1977. Priority date 7 Oct 1974, Japan. 6p.

High-pressure gas generating apparatus includes a gas generator body provided with a combustion chamber. The gas generator body has a primary propellant injector including orifices for injecting a primary fuel and orifices for injecting a primary oxidizing agent, both the orifices being open to the combustion chamber, an igniter for igniting the primary fuel forced out from the injector, and valve means having a secondary fuel injecting orifice for injecting a metal fuel into a high-temperature gas atmosphere to be reacted threwith and containing a secondary oxidizing agent produced by the reaction of the primary fuel injected from the primary propellant injector with the primary oxidizing agent similarly injected.

57078 External gas turbine engine cooling for clearance control. Redinger, I.H. Jr.; Sadowsky, D.; Stripinis, P.S. (to United Technologies Corp.). US Patent 4,019,320. 26 Apr 1977. Filed date 5 Dec 1975. 6p.

A reduction of the opening of the clearance between the outer air seal secured to the case of a turbo-fan engine and the tip of the turbine buckets is obtained by selectively turning on and off or modulating the cool air supply. The cool air is bled from the fan discharge duct and is directed externally of the engine case adjacent the seal. Circumferentially mounted spray bars are axially spaced to fit juxtaposed to the annular flanges extending from the engine case and carry a plurality of holes judiciously located to direct the flow of cool air to impinge on the side walls of the flanges to effectuate shrinkage of the case.

57079 Water injection device for internal combustion engines. Skaggs, W.D. US Patent 4,019,472. 26 Apr 1977. Filed date 9 Feb 1976. 6p.

A description is given of an improved device having no moving parts which, when in communication with the air intake of a carburetor of an internal combustion engine injects a mist of water into the air-fuel mixture formed by the carburetor. The water, when in the zone of combustion in the engine, reacts with carbon monoxide and free carbon to form carbon dioxide and hydrogen. The hydrogen so formed reacts with oxygen in the air-fuel mixture to form water that is either discharged in the exhaust from the engine or reacts with additional carbon dioxide and carbon in the zone of combustion to produce further carbon dioxide and hydrogen that continues until the carbon dioxide and water are discharged in the exhaust from the engine. The device when operating not only lowers the content of carbon monoxide in the exhaust discharged from the engine, but also tends to remove and minimize the depositing on carbon on spark plugs and in the cylinders of the engine.

57080 Stratified combustion type engine. Kamiya, M. US Patent 4,019,473. 26 Apr 1977. Priority date 5 Dec 1973, Japan. 4p.

The present invention relates to a stratified combustion type engine comprising an engine cylinder, a main combustion chamber located above the cylinder, an injection nozzle for injecting auxiliary fuel towards the combustion chamber, and an open pre-combustion chamber provided within the combustion chamber for locally holding and vaporizing the flow of auxiliary fuel from the injection nozzle. The pre-combustion chamber is internally equipped with a spark plug.

57081 Air-fuel ratio regulating apparatus for an internal combustion engine with exhaust gas sensor characteristic compensation. Nishimiya, T.; Sasayama, T. (to Hitachi, Ltd.). US Patent 4,019,474. 26 Apr 1977. Priority date 1 Nov 1974, Japan. 6p.

An apparatus is described which comprises a detector for detecting the density of one component (oxygen, for example) of exhaust gases from an internal combustion engine for regulating the ratio of air to fuel based on the detected value of the component in such a manner that the air-fuel ratio can be made approximate to the theoretical air-fuel ratio. The apparatus further comprises a first comparator having a hysteresis range and a second comparator having no hysteresis range for detecting the output of the detector for detecting the density of one component of exhaust gases, in order that vairations in the characteristics of the detector or changes in its characteristics with time can be compensated for.

57082 Automobile acceleration control for fuel economy. Nuss, C. (to Chrysler Corp.). US Patent 4,019,475. 26 Apr 1977. Filed date 6 Jun 1974. 10p.

Resilient means yieldably opposes opening of the throttle for an automobile engine when the latter is accelerated too rapidly for acceptable fuel economy. Pressure actuated means responsive to inlet manifold pressure withdraws the resilient means from the path of opening movement of the throttle to enable throttle opening without opposition by the resilient means when the rate of acceleration is sufficiently low to achieve the acceptable fuel economy. The throttle opposing force of the resilient means is readily detectable by the automobile driver, but may be overcome by him when rapid acceleration is desired. Also supplemental means under the control of the driver is provided for selectively withdrawing the resilient means from the path of throttle opening movement when no indication of rapid acceleration is desired.

EMISSION CONTROL

REFER ALSO TO CITATION(S) 57080, 57081

57083 Process for preparing catalytic materials for purifying exhaust gas and catalytic materials prepared thereby. Sakai, T.; Matsuo, K.; Tochio, Y. (to Mitsui Mining and Smelting Co., Ltd.). US Patent 4,028,275. 7 Jun 1977. Priority date 24 Jan 1973, Japan. 12p.

A catalyst for purifying exhaust gas may be prepared by a process comprising impregnating a ceramic carrier with an impregnating liquid containing at least one platinum group metal compound, at least one organic nitrogen compound and/or at least one organic phosphorus compound, drying the impregnated carrier, reducing the metal compound impregnated in the carrier to the corresponding metal and then calcining the metal on the carrier to obtain the desired catalyst. The invention also relates to the catalysts prepared by the process.

NITROGEN OXIDES

REFER ALSO TO CITATION(S) 57074

57084 Air-fuel ratio control system for use with internal combustion engine. Aono, S. (to Nissan Motor Co., Ltd.). US Patent 4,027,637. 7 Jun 1977. Priority date 14 Nov 1974, Japan. 6p.

Fuel injectors or a carburetor is electronically controlled to alternately deliver optimally rich and lean air-fuel mixtures to each combustion chamber.

57085 Diesel engines having advantageous emission characteristics for mining plants. Dietrich, W. *Glueckauf;* **113**: No. 2, 65-67(20 Jan 1977). (In German with English abstract).

Limit values of carbon monoxide and NO/sub x/ are determined. The D 916 diesel engine is introduced and evaluated. Economic significance of emissions is considered.

CARBON MONOXIDE

REFER ALSO TO CITATION(S) 57074, 57079

57086 Method of starting a combustion system utilizing a catalyst. Pfefferle, W.C. (to Engelhard Minerals and Chemicals Corp.). US Patent 4,019,316. 26 Apr 1977. Filed date 29 Dec 1975. 12p.

A method and system are provided for starting a combustion system utilizing a catalyst, and at the same time provide low emissions of unburned hydrocarbons and carbon monoxide. The method is particularly applicable to starting such combustion systems which are subject to intermittent operation, such as for example, gas turbines used to power automotive vehicles in which carbonaceous fuels are combusted to provide the motive fluid, or furnaces which are used intermittently. In the method, heat, such as produced by electrical means or by thermal combustion of a carbonaceous fuel, is employed to bring the catalyst to an operating temperature which will permit rapid oxidation of the carbonaceous fuel. When the catalyst has been heated to reach such operating temperatures, the start-up heating may be terminated and the normal operation of the combustion zone including the catalyst may proceed.

HYDROCARBONS

REFER ALSO TO CITATION(S) 57074, 57086

ALTERNATIVE FUELS

57087 Manganese containing fuels. Sprague, J.W.; Feldman, D.W.; Veatch, F. (to Standard Oil Co.). US Patent 4,028,065. 7 Jun 1977. Filed date 27 Nov 1974. 8p.

Gasoline, containing manganese additives to improve the octane rating of the gasoline, and a hydrocarbon ester of citric acid are described.

MATERIALS

REFER ALSO TO CITATION(S) 56930

57088 (ERDA—76-28V1) Federal look at the needs for energy-related materials research and development. Volume 1. Near-term energy program. (Federal Council for Science and Technology, Washington, D.C. (USA). Energy Task Group). 1976. 120p. Dep. NTIS, PC A06/MF A01.

The objectives of this volume are to specify materials requirements and to provide guidance for those making decisions on government-sponsored materials work in support of the near-term national energy program. The report is the culmination of a study requested by the Committee on Materials of the Federal Council for Science and Technology. Panels charged with the following areas reported: fossil energy; nuclear energy; solar and geothermal energy; energy conversion, storage, and transmission; conservation and recovery of materials and energy; materials supply and management; and multi-impact basic research and exploratory development. Comments on common technology needs, near-term benefits, and budgetary allocations are included. 3 figures, 37 tables. (RWR)

57089 (AEC-tr—7297/9) **Ukrainian Physics Journal.** Translation of *Ukr. Fiz. Zh. (Russ. Ed.);* 16: No. 9, 1409-1572(Sep 1971). 208p. (TT—72-52017/09). Dep. NTIS, PC A10/MF A01.

A cover-to-cover translation into English of Vol. 16, No. 10 of Ukrainskii Fizicheskii Zhurnal (September 1971) is given. Papers are included on materials properties, solid state physics, high-energy physics, and plasma physics. (RWR)

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 56477, 56529

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 55550, 55628, 56125, 56420, 56680, 56694, 56695, 56907, 56933, 57164, 57254

57090 (GEPP—297) **Electron beam welding using fusion and cold wire fill.** Kuncz, F.F. (General Electric Co., St. Petersburg, Fla. (USA). Neutron Devices Dept.). 27 May 1977. Contract EY-76-C-04-0656. 38p. Dep. NTIS, PC A04/MF A01.

A straight-fusion (self-filler) welding technique generally poses no problem for electron beam welding. However, where control of penetration is a critical item and burn-through cannot be tolerated, this technique may not be satisfactory. To assure against beam-spike burn-through on a 1/4-inch deep weld joint, a low-power root-fusion pass, supplemented by numerous filler passes, was selected. However, this technique proved to have numerous problems. Voiding and porosity showed frequently in the first applications of this cold-wire filler process. Taper-out cratering, bead-edge undercutting, and spatter were also problems. These imperfections, however, were overcome. Employment of a circle generator provided the necessary heating of the joint walls to eliminate voids. The moving beam spot also provided a stirring action, lessening porosity. Taper-out cratering was eliminated by adjusting the timing of the current cutoff and wire-feed cutoff. Undercutting, bead height, and spatter were controlled by beam defocus.

57091 (LBL—5772) **Studies of design parameters in the fabrication of Nb—Al—Ge superconductors by the powder metallurgy infiltration method.** Granda, J.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1976. Contract W-7405-ENG-48. 68p. Dep. NTIS, PC A04/MF A01.

Thesis.

Experimental studies have been carried out in which the A15 phase of the Nb-Al-Ge system has been synthesized in the form of thin filaments contained in form rolled wires. A powder metallurgy approach has been used to achieve controlled porosity in compacts of sintered niobium powder. Infiltration with an aluminum-germanium eutectic alloy followed by mechanical deformation has produced small interconnected filaments embedded in the Nb matrix. Diffusion heat treatment for a short time transforms them into the A15 superconducting compound with a size range of 1-5 microns at 1300°C and 1-9 microns at 1750°C. The superconducting properties T/sub c/ and J/sub c/ were evaluated for samples subjected to different condition of time and temperature. The influence of certain parameters involved in the process has been investigated. The microstructure and microhardness of the Al-Ge eutectic alloy cooled at high and low cooling rates from temperatures between 900-400°C have been evaluated. Optical and electron beam metallographic results are presented for the analysis of the different phases and relative compositions. The critical temperature measured inductively is between 16.4°K and 18.1°K depending on the heat treatment. The critical current density as a function of the applied magnetic field is reported. These data were obtained using a pulsed magnetic field technique that measured J/sub c/ at 4.2°K in fields up to 100 kG. J/sub c/ was 8.8 x 10^4 amp/cm^2 at 20 kG and 3.6 x 10^4 amp/cm^2 at 60 kG for specimens containing approximately 20% A15 phase.

57092 (N—77—16075) **Analytical study of space processing of immiscible materials for superconductors and electrical contacts. Final report, 28 May 1975 - 30 Sep. 1976.** Gelles, S.H.; Collings, E.W.; Abbott, W.H.; Maringer, R.E. (Battelle Columbus Labs., Ohio (USA)). Jan 1977. Contract NAS8-31445. 64p. (NASA-CR—150156). NTIS PC A04/MF A01.

The results of a study conducted to determine the role space processing or materials research in space plays in the superconductor and electrical contact industries are presented. Visits were made to manufacturers, users, and research organizations connected with these products to provide information about the potential benefits of the space environment and to exchange views on the utilization of space facilities for manufacture, process development, or research. In addition, space experiments were suggested which could result in improved terrestrial processes or products. Notable examples of these are, in the case of superconductors, the development of Nb-bronze alloys (Tsuei alloys) and, in the electrical contact field, the production of Ag-Ni or Ag-metal oxide alloys with controlled microstructure for research and development activities as well as for product development. A preliminary experimental effort to produce and evaluate rapidly cooled Pb-Zn and Cu-Nb-Sn alloys in order to understand the relationship between microstructure and superconducting properties and to simulate the fine structure potentially achievable by space processing was also described.

57093 (N—77—16082) **Space Processing Applications Rocket project, SPAR 1. Final report.** Reeves, F.; Chassay, R. (National Aeronautics and Space Administration, Huntsville, Ala. (USA). George C. Marshall Space Flight Center). Dec 1976. 305p. (NASA-TM-X—3458; M—196). NTIS PC A14/MF A01.

The experiment objectives, design/operational concepts, and final results of each of nine scientific experiments conducted during the first Space Processing Applications Rocket (SPAR) flight are summarized. The nine individual SPAR experiments, covering a wide and varied range of scientific materials processing objectives, were entitled: solidification of Pb-Sb eutectic, feasibility of producing closed-cell metal foams, characterization of rocket vibration environment by measurement of mixing of two liquids, uniform dispersions of crystallization processing, direct observation of solidification as a function of gravity levels, casting thoria dispersion-strengthened interfaces, contained polycrystalline solidification, and preparation of a special alloy for manufacturing of magnetic hard superconductor under zero-g environment.

57094 (PB—264702) **Utilization of low and intermediate Btu gas from coal for iron ore pelletizing. Open file report, Jul 1975—Mar 1977.** Ashworth, R.A.; Vyas, K.C.; Bonamer, D.G. (McKee (Arthur G.) and Co., Cleveland, Ohio (USA)). Mar 1977. Contract J0255021. 283p. NTIS PC A13/MF A01.

Technical and economic feasibility of gasification of low rank solid fuels to provide fuel gas for firing iron ore pelletizing furnaces in northern Minnesota are discussed. Comparisons are made of several types of gasifiers, gas characteristics, and economics of large, centrally located gasification plant with gasification facilities at individual pellet plants. Costs of retrofitting to grate-kiln, traveling grate, and shaft type furnaces are compared.

57095 (SAND—77-0373) **Ion implantation in metals.** Vook, F.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). Feb 1977. Contract EY-76-C-04-0789. 23p. Dep. NTIS, PC A02/MF A01.

The application of ion beams to metals is rapidly emerging as a promising area of research and technology. This report briefly describes some of the recent advances in the modification and study of the basic properties of metals by ion implantation techniques. Most of the research discussed illustrates some of the new and exciting applications of ion beams to metals which are under active investigation at Sandia Laboratories, Albuquerque.

57096 **Effects of rapid quenching of superconductors.** Savitskii, E.M.; Efimov, Y.V. (A. A. Baikov Institute of Metallurgy, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Dokl. (Engl. Transl.);* 22: No. 2, 91-93(Feb 1977).

Superfast quenching is used to produce metastable superconducting phases with high Tc in V_3Ti, VC, and (Nb,Ti) N/sub x/ .(AIP)

57097 **New and advanced technological process of manufacture of connecting pipes on frames of nuclear power plants by electroslag welding.** Paton, B.E.; Tupitsyn, L.V.; Sobolev, Yu.V.; Medovar, B.I.; Ardentov, V.V.; Kovalev, V.A.; Ignatov, V.A.; Shavrin, A.I.; Popov, V.G.; Rukhlin, P.N.; Trofimov, I.F. *Energomashinostroenie;* No. 1, 27-29(1977). (In Russian).

A new technology of making connecting pipes is described. It is fairly simple and ensures guaranteed quality of the connecting pipes at their junctions with the frame. It consists in the following: Cooled copper crystallizers are installed at the spot where the connecting pipes are to be formed. Molten flux is poured into the working cavity of the crystallizer. Consumable electrodes are inserted from the top into the crystallizers and the process of electroslag welding is carried out.

57098 Mastering the process of cold bending of pipes for a small radius in Soviet boilermaking. Bondarenko, V.T. *Energomashinostroenie;* No. 1, 37-39(1977). (In Russian).

Problems of mastering, for the first time in the practice of Soviet power engineering, the process of cold bending of pipes for a small radius on Teledyne Pines pipe bending machines installed at a number of Soviet power engineering works are considered.

57099 Coatings application for fusion research. Simpkins, J.E. (Oak Ridge Natl Lab, TN). *Thin Solid Films;* **39**: No. 1-2-3, 321-327(Dec 1976).

A large stainless steel toroidal inner vacuum liner, with a major radius of 79.5 cm and minor radius of 23.5 cm, has been coated with gold to minimize gas adsorption and to provide an inert surface for the plasma in ORMAK, a fusion experiment. A thin platinum film, deposited prior to the gold coating, acts as a diffusion barrier and prevents many of the constituents of the steel from diffusing through the gold to the surface. In a fusion reactor the walls exposed to the plasma will be bombarded by highly energetic neutrals, and a gold surface may not be suitable because of its relatively high sputtering yield. The techniques employed to deposit several of the candidate materials onto stainless steel substrates as thick coatings are described.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 57119

57100 (AD-A—037760) **Research in materials science. Final technical report.** Maurer, R.J. (Illinois Univ., Urbana (USA). Materials Research Lab.). Jan 1977. Contract F44620-75-C-0091,. 55p. NTIS PC A04/MF A01.

The quaternary semiconductor In/sub 1-x/Ga/sub x/P/sub 1-z(As/sub Z/ has been exploited to construct light emitting and laser diodes with selective emission from the yellow of the visible spectrum to the infrared. The properties of deep traps which affect the performance of silicon devices has been characterized. Molecular interactions and fast atomic motion has been investigated in liquids, liquid crystals, organic semiconductors, ionic superconductors, layered dichalcogenides and superconductor alloys. (Author)

57101 (CALT—822-95) **NMR and Moessbauer studies of the amorphous system $Fe_{79}P$/sub 21-x/B/sub x/.** Amamou, A.; Durand, J. (California Inst. of Tech., Pasadena (USA). W.M. Keck Lab. of Engineering Materials). May 1977. Contract EY-76-C-03-0822. 21p. Dep. NTIS, PC A02/MF A01.

Combined NMR, spin-echo and Moessbauer experiments have been performed to obtain hyperfine field distributions of the transition metal and metalloid elements in splat-cooled amorphous $Fe_{79}P_{31}$/sub -x/B/sub x/ alloys. These distributions are related to the local environments of the elements. The NMR signals are observed in the low frequency range 20-60 MHz and all the nuclei, i.e. Fe, P and B, may contribute to the spectral distribution. The resolution of the spectra into that due to Fe and (P + B) nuclei was made possible by using samples prepared with an Fe^{56} isotope. The Fe distribution thus obtaned shows general agreement with the Moessbauer field distribution. From a careful analysis of the NMR data, the hyperfine field at the B nuclei in these amorphous alloys is found to range from 24 to 26 KG increasing with B content. An upper limit of 8 KG for the half-width is attributed to this distribution. The Moessbauer spectra of the Fe^{57} nuclei resemble those for the crystalline $Fe_{75}P_{25}$/sub -x/B/sub x/ alloys. A fit of the spectra shows a field distribution which suggests the presence of structure. Such a structure may correspond to various Fe sites, also seen in the crystalline alloys. The distributions generally lie between about 160 and 330 KG, with a maximum at about 260 KG. These spectra do not show the presence of Fe nuclei with essentially zero hyperfine field as was obtained for amorphous Fe-Pd-P by Sharon et al. and for amorphous Fe-P by Logan et al. With increasing B content the center of gravity of the Fe distribution shifts to higher values. From a systematic study of the NMR lines and other considerations it is concluded that the P field distribution is broad and its hyperfine field is between 20 and 35 KG for the higher P concentration alloys.

57102 (COO—1198-1181) **Science of materials. Progress report, July 1, 1976—June 30, 1977.** (Illinois Univ., Urbana (USA). Materials Research Lab.). Mar 1977. Contract EY-76-C-02-1198. 160p. Dep. NTIS, PC A08/MF A01.

The Metallurgy and Ceramics research described includes the investigation of the mechanical properties of metals and alloys, fracture, corrosion of metals, the defect and catalytic properties of oxides, and the structure of polymers and liquids. Emphasis is placed on the role of light interstitial alloying agents in affecting mechanical properties of metals with particular attention to hydrogen as an embrittlement agent. The Solid State Physics research includes the investigation of electronic properties of phosphors, semiconductors, dichalcogenide layer compounds, hydrocarbon catalysts and magnetic impurities. The study of crystalline defects is a major concern of the program. Dislocation mechanisms of plastic flow have been investigated and point defect studies include diffusion in refractory metals and quantum effects on vacancy migration in helium crystals. Of special interest has been the defect structures conducive to fast ion motion in superionic crystals and the roles of covalent binding and defects in determining the hardness of the transition metal carbide compounds.

57103 (COO—3150-39) **Transmission electron spin resonance in dilute CuFe alloys.** Ritter, A.L.; Silsbee, R.H. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA); Cornell Univ., Ithaca, N.Y. (USA)). May 1977. Contract EY-76-S-02-3150. 34p. Dep. NTIS, PC A03/MF A01.

Alloys of Cu with nominally 5 and 10 at ppM Fe were studied by transmission electron spin resonance in the temperature range 2K to 40K. These measurements represent the first reported observation of electron spin resonance in a dilute magnetic alloy below its Kondo temperature. The relaxation rate of these alloys roughly scales with Fe concentration and exhibits a clear minimum at approximately 25K, the contribution of the Fe impurities to the relaxation rate of the alloys is 7.7 +- 0.9 x 10^8/sec.-at. ppM at 25K. The g-value of the alloys did not deviate from the g-value of pure Cu within the experimental scatter. We analyze our results in terms of coupled Bloch equations and discuss possible mechanisms for the inferred local moment-lattice and conduction electron-lattice relaxation rates.

57104 (COO—4246-1) **Microstructural effects in abrasive wear. Quarter progress report, 15 March 1977—15 June 1977.** Fiore, N.F. (Notre Dame Univ., Ind. (USA). Dept. of Metallurgical Engineering and Materials Science). 1 Jul 1977. Contract EF-77-S-02-4246. 14p. Dep. NTIS, PC A02/MF A01.

Correlation of the microstructural features of alloy cast irons and Co-base alloys to their wear resistance under room temperature low-stress and high-stress (gouging) abrasion is discussed. Low-stress abrasion resistance is determined on a dry-sand rubber wheel device, whereas high-stress abrasion resistance is measured in a grinding wheel test. The microstructures of the test materials are characterized by automated image analysis techniques.

57105 (LBL—6266) **Kinetics of formation of the A-15 phase in the Nb—Al—Ge system.** Kannatey-Asibu, E. Jr. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1977. Contract W-7405-ENG-48. 46p. Dep. NTIS, PC A03/MF A01.

Thesis.

A study has been made of the time and temperature dependence of the growth of the A-15 phase and its grains in the Nb-Al-Ge system. In addition, changes in the microstructure and composition of the A-15 phase have been studied using an EDAX analysis. The data obtained have been plotted and compared with theory. The results have been used to explain the variations in the superconducting properties of this system as observed in earlier work. Consequently, areas for further study towards optimizing the superconducting parameters of this system have been proposed.

57106 (UCRL—79032) **Metallic high pressure equation-of-state derived from experimental data.** Grover, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Jul 1977. Contract W-7405-ENG-48. 11p. (CONF-770706—18). Dep. NTIS, PC A02/MF A01.

From 6. AIRAPT international high-pressure conference; Boulder, Colorado, United States of America (USA) (25 Jul 1977).

A program of making "global" fits to the large amount of experimental equation-of-state data on monatomic metals that has become available in recent years is described. The fits are made within the framework of a phenomenological scaling theory for metallic liquids which incorporates recently discovered general theoretical properties of the EOS of liquids. The theory is expected to be applicable to monatomic metals up to high temperatures (approximately 10 to 100 times the melting temperature, T/sub m/) and at all densities, so long as the metallic bonding does not change character. (GHT)

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 56302, 56385, 56470, 56496, 56498, 56503, 56505, 56518, 56521, 56565, 56674, 56676, 56694, 56695, 56755, 56906, 57091, 57259, 57261, 57262, 57822

57107 (BNL—23016) **Influence of tensile stresses on the superconducting temperature of multifilamentary Nb_3Sn composite conductors.** Luhman, T.; Suenaga, M.; Klamut, C.J. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 17p. (CONF-770801—15). MF A01.

From Cryogenic engineering conference; Boulder, Colorado, United States of America (USA) (2 Aug 1977).

The need for Nb_3Sn multifilament conductors in large magnet systems has generated interest in the mechanical and associated

electrical properties of these composites. The superconducting compound (Nb_3Sn) in bronze processed conductors is subjected to a compressive strain originating from thermal contraction of the outer bronze matrix. Such compressive strains lower the compound's superconducting temperature, T/sub c/ and critical current density, J/sub c/, while removal of the compressive strains by etching off the bronze matrix restores T/sub c/ and J/sub c/. Recent investigations have suggested that tensile loading of these composite superconductors can increase T/sub c/. In this report a study is presented of T/sub c/ and its relationship to both internal prestrains and applied tensile loads at 4.2 K in these composite superconductors.

57108 (CONF-760503—P2, pp 462-469) **Compatibility of bismuth and bismuth—lithium solutions with refractory metals and graphite.** DiStefano, J.R. (Oak Ridge National Lab., TN). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Capsule and thermal-convection loop tests were conducted at temperatures up to 700°C to determine the compatibility of several materials in bismuth and bismuth-lithium solutions. Methods of evaluation included weight change, electron microprobe analysis, mechanical properties tests, and metallographic examination. Graphite, molybdenum, and Ta-10 percent W appear to be the most promising containment materials, while niobium and iron-base alloys are unacceptable.

57109 (CONF-770807—8) **Use of a modified beam in obtaining creep data in uniaxial tension and compression.** Robinson, D.N. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

A method of testing is presented which makes use of a special "slotted" beam to compare the tensile and compressive creep response of a metal at high temperature. The technique avoids most of the difficult alignment problems associated with conventional uniaxial testing in compression. Application of the method is made to 2¼ Cr-1 Mo steel, a primary reactor system metal. It is concluded that the elastic-creep behavior of this alloy is effectively the same in compression as in tension. Moreover, the "slotted" beam is judged a practicable tool for obtaining reliable creep data in tension and compression.

57110 (COO—2733-11) **Mechanical behavior of materials and structural elements at elevated temperatures. Progress report, June 1, 1976—May 31, 1977.** Lance, R.H.; Mukherjee, S. (Cornell Univ., Ithaca, N.Y. (USA)). May 1977. Contract EY-76-S-02-2733. 23p. Dep. NTIS, PC A02/MF A01.

The analytical research performed includes solutions of boundary value problems for several structural elements using Hart's constitutive relations with and without the presence of anelastic strains. Research is in progress on the use of boundary-integral equation methods to solve inelastic deformation problems for planar bodies. The design and fabrication of a creep testing facility with auxilliary force, temperature and displacement transducers and data acquisition system is complete and creep experiments on beams at room temperature are in progress.

57111 (COO—3084-52) **Segregation induced embrittlement of grain interfaces.** Mason, D.D. (Brown Univ., Providence, R.I. (USA). Div. of Engineering). May 1977. Contract EY-76-S-02-3084. 41p. Dep. NTIS, PC A03/MF A01.

Conditions are discussed under which an interface, possibly containing an adsorbed species, is capable of sustaining an atomistically sharp cleavage crack, rather than having any such crack blunt out via dislocation nucleation. Two models for ductile versus brittle interface response are discussed. One of these is applied to model grain boundaries in face centered cubic materials, and is used to compare predictions with experimental observations on the embrittlement of Cu polycrystals by the addition of dilute concentrations of Bi. The general results are in qualitative agreement, although the model predicts behavior that is, in general, more ductile than that observed experimentally. Several possible reasons for this excess ductility are discussed. An appendix presents an analysis of the work of reversible separation of an interface containing a segregated species. This is intended to clarify some issues recently raised in the literature on interfacial embrittlement, especially concerning the distinctions that must be drawn between expressions for cohesive energy reductions for interfacial separation at constant chemical potential, μ, versus separation with constant concentration, Γ, of the adsorbate species.

57112 (GEFR—14029-11) **Steam generator materials engineering eleventh quarterly report, January—March 1977.** Challenger, K.D. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Apr 1977. Contract EY-76-C-03-0893-018. 49p. .

This report is part of a series of quarterly progress reports published under the Steam Generator Materials Engineering Program. The primary objective of the work reported is to characterize materials, mainly 2-1/4 Cr-1 Mo and stainless steels, to assure that satisfactory materials compatibility is achieved with expected LMFBR steam generator environments.

57113 (LA-UR—77-1292) **Determination of the Grueneisen γ for beryllium at 1.2 to 1.9 times standard density.** Neal, T. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 24p. (CONF-770706—14). Dep. NTIS, PC A02/MF A01.

From 6. AIRAPT international high-pressure conference; Boulder, Colorado, United States of America (USA) (25 Jul 1977).

In shock-wave work, a simple approximation that works well for metals assumes that the ratio of the Grueneisen parameter to the specific volume remains constant during compression. The results of the various experiments on beryllium are displayed in terms of that ratio. The experiments that involved a high-impedance reflector were not as precise as the others. The weighted average value of γ/V is indicated as a dashed line. For all of the higher compression experiments, the determination of γ involved a comparison of an experimentally achieved state with one of the same compression on the principal Hugoniot. Experimental data for the principal Hugoniot, however, are not available for volumes less than 0.35 m^3/Mg. Thus, the four highest compression results are really determined from a comparison with the extrapolation of the experimental principal Hugoniot.

57114 (LBL—6012) **Effect of silicon on the environmental cracking behavior of a high strength steel.** Cedeno, M.H.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1977. Contract W-7405-ENG-48. 68p. Dep. NTIS, PC A04/MF A01.

Thesis.

The effect of silicon on the environmental cracking behavior of high strength steels was investigated by testing AISI 4340 and 300-M steels in various environments. Results show that, whether it was used as an austenite stabilizer or as a solid solution strengthener, silicon reduced steady-state crack velocities by substantial amounts. Lifetimes, however, appear to depend more on fracture toughness than on any other parameter. The present work has confirmed that the environmental cracking behavior of a material can be modified by composition and heat treatment variation; therefore, the possibility of designing environmental cracking-resistant alloys should be explored further. 15 figures, 2 tables.

57115 (N—77—16149) **The stress corrosion resistance and the cryogenic temperature mechanical properties of annealed Nitronic 60 bar material.** Montano, J.W.L. (National Aeronautics and Space Administration, Huntsville, Ala. (USA). George C. Marshall Space Flight Center). Jan 1977. 31p. (NASA-TM-X—73359). NTIS PC A03/MF A01.

Ambient and cryogenic temperature mechanical properties and the ambient temperature stress corrosion properties of annealed, straightened, and centerless ground Nitronic 60 stainless steel alloy bar material are presented. The mechanical properties of longitudinal specimens were evaluated at test temperatures from ambient to liquid hydrogen. The tensile test data indicated increasing strength with decreasing temperature to -196 C. Below liquid nitrogen temperature the smooth tensile and notched tensile strengths decreased slightly while the elongation and reduction of area decreased drastically. The Charpy V-notched impact energy decreased steadily with decreasing test temperature. Stress corrosion tests were performed on longitudinal tensile specimens and transverse C-ring specimens exposed to alternate immersion in a 3.5% NaCl bath, humidity cabinet, and a 5% salt spray atmosphere. The longitudinal tensile specimens experienced no corrosive attack. Approximately 3/4 of the transverse C-rings exposed to alternate immersion and to salt spray experienced a pitting attack on the top and bottom ends. Additional stress corrosion tests were performed on transverse tensile specimens. No failures occurred in the 90% stressed specimens exposed for 90 days in the alternate immersion and salt spray environments. Low-temperature mechanical properties of austenitic stainless nickel steel were examined; variables include temperature effects, impact resistance, tensile strength, yield strength, elongation, fracture resistance, modulus of elasticity, shrinkage, notch strength. 2 figures and 5 tables are included.

57116 (ORNL—5273) **Creep and rupture behavior of a bainitic (normalized and tempered) 2 1/4 Cr—1 Mo steel.** Klueh, R.L. (Oak Ridge National Lab., Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 30p. .

The creep-rupture behavior of a normalized and tempered 2¼ Cr-1 Mo steel was determined at 454, 510, and 566°C. Tests were made on specimens taken from a commercial heat of steel where the microstructure was completely bainitic. In addition to the creep-rupture behavior, secondary and tertiary creep behavior were also examined. A relationship between the onset of tertiary creep and

rupture life was obtained. The results from these tests were compared with available data on annealed, normalized and tempered, and quenched and tempered base metal and with tempered weld metal. The results of these comparisons gave insights into the types of precipitation reactions that occur in 2¼ Cr-1 Mo steel.

57117 (SAND—77-0027C) **High pressure multiple shock response of aluminum.** Lawrence, R.J.; Asay, J.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 20p. (CONF-770706—16). Dep. NTIS, PC A02/MF A01.

From 6. AIRAPT international high-pressure conference; Boulder, Colorado, United States of America (USA) (25 Jul 1977).

It is well known that both dynamic yield strength and rate-dependent material response exert direct influence on the development of surface and interface instabilities under conditions of strong shock loading. A detailed understanding of these phenomena is therefore an important aspect of the analysis of dynamic inertial confinement techniques which are being used in such applications as the generation of controlled thermonuclear fusion. In these types of applications the surfaces and interfaces under consideration can be subjected to cyclic loading characterized by shock pressures on the order of 100 GPa or more. It thus becomes important to understand how rate effects and material strength differ from the values observed in the low pressure regime where they are usually measured, as well as how they are altered by the loading history.

57118 (UCRL—79712) **Response of porous beryllium to static and dynamic loading.** Isbell, W.M.; Walton, O.R.; Ree, F.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1977. Contract W-7405-ENG-48. 26p. (CONF-770706—17). Dep. NTIS, PC A03/MF A01.

From 6. AIRAPT international high-pressure conference; Boulder, Colorado, United States of America (USA) (25 Jul 1977).

Previous investigstions of the mechanical response of porous materials to dynamic loading have been extended to include the shock wave response of a brittle metal. The complex response of berylliums of 85 to 90 percent porosity in two initial conditions has been examined in a theoretical and experimental program to be described. The study has resulted in the development of constitutive relations placed in hydrocodes which are capable of accurately predicting wave propagation in the berylliums. A comprehensive set of static (0 to 4 Gpa) and dynamic (0 to 35 Gpa) experiments was performed to measure the behavior of these brittle, porous materials to imposed loads. The results of the experiments guided a modeling effort which added several new features to previous models, including deviatoric stresses, porosity-dependent relaxation time of pore closure, elastic-plastic reopening of pores, and improved compaction functions.

57119 (WARD-AD—3045-5) **Characterization and aging kinetics study of gamma prime strengthened Fe—Cr—Ni experimental alloys for breeder reactors.** Chang, A.L.; Baron, I.M.; Bleiberg, M.L. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Jul 1977. Contract EY-76-C-02-3045-024. 69p. .

A series of Fe—Cr—Ni based γ′ strengthened austenitic alloys were characterized optically and by transmission electron microscopy. A uniform dispersion of spherical γ′ particle was observed to be the major precipitated phase throughout the matrix. Long term aging experiments showed phase stability in these alloys. The γ′ aging kinetic data of average particle radius, γ′ volume fraction and γ′ particle concentration were analyzed in terms of a new particle coarsening theory which accounts for increasing volume fraction and reduces to the Liftshitz-Slyozov-Wagner (L-S-W) result in the asymptotic limit. It was found that the experimental data substantiate the new theory and that the diffusion coefficient and the L-S-W parameter can be uniquely determined. It was found that the equilibrium γ′ volume fraction increases with (Ni + Ti + Al) content and the γ-γ′ interfacial energy decreases with additions of Si, B, C, and Mo. It was also found that depletion of solute supersaturation in the double aging treatment does not follow the usual t^-/sup ⅓/ law for the single aging treatment. The supersaturation was depleted mostly by growth of already existing large particles and it decayed exponentially with double aging time.

57120 **Experimental assessment of the Mindlin—McNiven rod theory.** McNiven, H.D.; Mengi, Y. (University of California, Berkeley, California 94720). *J. Acoust. Soc. Am.;* **62**: No. 3, 589-594(Sep 1977).

The three-mode theory due to Mindlin and McNiven [J. Appl. Mech. 27, 145—151 (1960)], governing axisymmetric motions in a circular rod, is appraised by comparing responses predicted by it with experimental data obtained by Miklowitz and Nisewanger [J. Appl. Mech. 24, 240—244 (1957)]. The problem studied involves a semi-infinite rod, made of 24S-T aluminum alloy, subjected to pressure applied to the end of the rod. The two sets of responses are compared at various stations along the rod. To make the comparisons meaningful, it was necessary to recognize that the pressure applied experimentally had a finite rise time, however short; to make an estimate from the responses of what that rise time might be; and then apply this time distribution of pressure in evaluating the theoretical responses. Comparison shows that the Mindlin—McNiven theory predicts the responses at stations farther than one diameter from the end of the rod. The matching is accurate not only at the head of the impulse but at points representing large times following the first disturbance.

57121 **Means for extending the service life of the metal of high-temperature elements of high-capacity power units.** Zorev, N.N.; Kryanin, N.R.; Trusov, L.P. (Cent Sci Res Inst of Heavy Mach, USSR). *Teploenergetika (Moscow);* No. 10, 2-6(Oct 1976). (In Russian).

An analysis is given of the results of experimental investigations of the metal of parts of power plant equipment after prolonged operation. Principal attention, it is concluded, should be paid to improving the quality of the material, enhance standardization of parts, specialize production and modernize construction technology.

57122 **Ways to solve the problem of extending the service life of existing and projected steam pipelines beyond 100,000 hr.** Adamovich, V.K. (Cent Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 10, 6-9(Oct 1976). (In Russian).

Results of investigations carried out at the Central Boiler and Turbine Institute on the title problem are presented. A method for extending the strength of pipe steel beyond 200,000 hr of service life is presented.

57123 **Working capacity and reliability of pipes made of steel 12Cr1MoV after long periods of operations.** Lanskaya, K.A.; Shvets, V.V.; Kulikova, L.V. (Cent Sci Res Inst of Ferrous Metall, USSR). *Teploenergetika (Moscow);* No. 10, 9-12(Oct 1976). (In Russian).

Results of investigations into the effect of operation on the structure and properties of steel 12Cr1MoV are summerized. It is shown that pipes with initial recommended structure can remain in operation beyond their rated service life.

57124 **Effect of stress concentrators on the strength of pipes of boiler heating surfaces made of 12cr1mov and Cr18Ni12Ti steel grades.** Zelenskii, V.G.; Plotnikov, V.P. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 10, 20-22(Oct 1976). (In Russian).

Tubular specimens of Cr18Ni12Ti and 12Cr1MoV steel grades with lengthwise notches are tested for their carrying capacity and ultimate strength. Results of tests are presented in tabular and graph form. Recommendations are given on permissible values of defects and residual deformation.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 56456, 56838, 57091, 57096, 57105, 57107, 57141

57125 (BNL—23053) **Mechanism for the degradation of superconducting transition temperatures on high energy neutron radiation in A-15 compounds.** Pande, C.S. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 13p. (CONF-770649—4). Dep. NTIS, PC A02/MF A01.

From International discussion meeting of radiation effects in superconductors; Argonne, Illinois, United States of America (USA) (13 Jun 1977).

Electron microscopic observations of neutron irradiated Nb_3Sn revealed the presence of highly disordered regions of size approximately 35A in a much less disordered matrix. This observation is shown to provide a means of explaining quantitatively many superconducting properties of irradiated A-15 compounds. In particular T/sub c/ of the radiated materials could be easily predicted using the mathematical formulations developed for the proximity effect.

57126 (CALT—822-88) **Magnetic regimes in amorphous Ni—Fe—P—B alloys.** Durand, J. (California Inst. of Tech., Pasadena (USA). W.M. Keck Lab. of Engineering Materials). Oct 1976. Contract EY-76-C-03-0822. 27p. Dep. NTIS, PC A03/MF A01.

A complete substitution of iron for nickel was obtained by splat-cooling in amorphous alloys of composition (Ni/sub 100-y/Fe/sub y/)$_{79}P_{13}B_8$. Results of high-field magnetization (up to 70 kOe), ac and dc low-field susceptibility, Curie temperature, and resistivity measurements over a temperature range of 1.7 to 300°K are reported. The $Ni_{79}P_{13}B_8$ alloy is not ferromagnetic, but the magnetization behavior as a function of field and temperature is typically that of alloys in the critical concentration range for ferromagnetism. The $Fe_{79}P_{13}B_8$ alloy is ferromagnetic with a Curie temperature T/sub c/ of 616°K. For y = 1 at. percent, the Fe atoms are magnetic. The variation of the moment per Fe atom as a function of y is discussed. When y is increased, the Ni atoms are likely to be polarized progressively and the moment per Ni atom would be roughly constant for y equal to or greater than 30 at. percent. Various magnetic behaviors were defined as a function of the Fe content. The value of T/sub c/ reaches a maximum for y similarly ordered 90

at. percent and extrapolates to zero for y similarly ordered 7 at. percent. Alloys within the range 1 equal to or less than y equal to or less than 10 at. percent did not exhibit well-defined Curie transition, but sharp maxima in low-field susceptibility measurements were observed at T/sub M/. The value of T/sub M/ is proportional to y for 1 equal to or less than y equal to or less than 4 at. percent, as in classical spin-glass regimes. For 4 less than y equal to or less than 10 at. percent, the variation of T/sub M/ as a function of y implies a more complicated type of magnetic ordering (micromagnetism or superparamagnetism). Homogeneous ferromagnetic ordering emerges only for y greater than 10 at. percent. Results of resistivity measurements are discussed in relation to the magnetic properties of different regimes in the magnetic phase diagram. 6 figures, 2 tables.

57127 (CALT—822-91) **Ferromagnetic and antiferromagnetic coupling in amorphous (Ni/sub 100-c/Mn/sub c/)$_{78}$P$_{14}$B$_8$.** Amamou, A. (California Inst. of Tech., Pasadena (USA). W.M. Keck Lab. of Engineering Materials). Dec 1976. Contract EY-76-C-03-0822. 19p. Dep. NTIS, PC A02/MF A01.

The magnetic properties of amorphous alloys (Ni/sub 100-c/Mn/sub c/)$_{78}$P$_{14}$B$_8$ with 0.7 at. percent equal to or less than c equal to or less than 20 at. percent were investigated for temperatures between 1.7 and 270°K. Samples were prepared by the splat cooling method; the susceptibilities at zero field and the magnetizations in fields up to 70 kOe were measured. Ni$_{78}$P$_{14}$B$_8$ is paramagnetic, and Ni—Mn—P—B alloys exhibit different magnetic characteristics depending on the manganese concentration and the temperature range. At "high temperature" T equal to or greater than 30°K the initial susceptibility has a Curie—Weiss behavior; all the paramagnetic Curie temperatures, theta, are equal to zero or positive. The low-temperature studies show that three concentration regimes can be determined; for c equal to or less than 2 at. percent, a dilute alloy behavior is observed. For higher manganese concentrations the magnetization features show the existence of a mixing of ferromagnetic and antiferromagnetic coupling between atoms. For 2 at. percent less than c equal to or less than 8 at. percent the alloys present spin glass characteristics, i.e., a random magnetic coupling occurs between magnetic moments. For 8 at. percent less than c equal to or less than 20 at. percent the alloys are micromagnetic and show a trend toward an antiferromagnetic order; irreversible phenomena are observed. In this paper the experimental results are interpreted and discussed in relation with the spin glass and micromagnetic models. 5 figures.

57128 (CONF-770537—4) **Equations of state for alkali metals near their critical points.** Blander, M.; Leribaux, H.R. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 16p. Dep. NTIS, PC A02/MF A01.

From 7. symposium on thermophysical properties; Gaithersburg, Maryland, United States of America (USA) (10 May 1977).

Equations of state of alkali metals which provide a good representation of the thermodynamic properties of alkali metals, especially up to their critical temperatures and beyond, and also have a form consistent with quantum mechanical theory are discussed. (GHT)

57129 (IS-M—96) **Surface and electrocatalytic properties of tungsten bronzes.** Weber, M.F.; Shanks, H.R. (Iowa State Univ. of Science and Technology, Ames (USA). Energy and Mineral Resources Research Inst.). 1977. Contract W-7405-ENG-82. 7p. (CONF-751234—2). Dep. NTIS, PC A02/MF A01.

From Meeting of electrocatalysis on non-metallic surfaces; Gaithersburg, Maryland, United States of America (USA) (9 Dec 1975).

Tafel plots have been obtained for the oxygen reaction in acid solution on several alkali tungsten bronzes having different crystal structures. Platinum doped sodium tungsten bronze crystals were studied and the results compared with those of platinum free crystals of the same composition. In both cases sodium tungsten bronzes were found to be poor electrocatalysts for the cathodic reduction of oxygen. Similar results are reported for other alkali tungsten bronzes and for tungsten trioxide. Anodic treatment of the crystals affected the electrocatalytic activity of only the sodium tungsten bronze and the effect was a negative one. Cyclic voltammetry was employed to study the effects of the anodic treatment which created a sodium depletion layer on the sodium tungsten bronze surface. The existence and depth of the sodium depletion layer was determined by an Auger Electron Spectroscopy depth profile.

57130 Relationship between defect resistivity and bulk resistivity at the melting temperature. Benedek, R. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **48**: No. 9, 3832-3834(Sep 1977).

An apparent correlation exists between the specific resistivity of intrinsic point defects (i.e., vacancies and interstitials) and bulk resistivity at the melting temperature for cubic metals. A theory based on the rigid-ion model and Lindemann's melting criterion is proposed to account for this correlation. The ratio of the defect resistivity to the melting-temperature resistivity is related to the defect-formation volume in an infinite crystal (i.e., without the image-field correction).

57131 Solubility of lithium oxide in liquid lithium. Yonco, R.M.; Maroni, V.A. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 166-167(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57132 Steel grades for tubes of heating surfaces of high-capacity highly efficient boilers. Antikain, P.A.; Zusman, V.M.; Gasho, T.V.; Grebennikova, T.T.; Mikulina, Yu.D.; Samarets, G.N.; Tikhonova, V.V. (Cent Boiler and Turbine Inst, Moscow, USSR). *Teploenergetika (Moscow);* No. 10, 16-19(Oct 1976). (In Russian).

A survey of new tube steel grades for boiler heating surfaces is presented. An analysis of experimental tests and published data shows that present-day tube steel grades permit operation with live steam temperature when burning all kinds of fuel, except high sulfur-content fuel oil, at the level of 565 C. When using traditional steel grades, the temperature of live steam should be limited to 545-550 C in gas/fuel oil-fired boilers. The newly tested EP184, EP17, and EI695R chromium-manganese-nickel steel grades permit live steam superheating temperature to be raised to 580--585 C (the limiting temperature of the metal is 680 C).

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 55548, 55725, 55798, 55806, 55975, 56262, 56295, 56379, 56431, 56455, 56499, 56517, 56519, 56520, 56522, 56523, 56524, 56525, 56526, 56527, 56528, 56540, 56542, 56565, 56682, 56781, 56783

57133 (CONF-760503—P1, pp 446-452) **Corrosion of ferrous alloys in nitrogen contaminated liquid lithium.** Olson, D.L.; Bradley, W.L. (Colorado School of Mines, Golden). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

Liquid lithium penetration of 304L stainless steel and Armco iron grain boundaries has been studied. The penetration kinetics for the 304L stainless steel was found to be diffusion controlled. The measured temperature dependent delay time has been associated with the initial formation of the corrosion product at the grain boundary. Nitrogen in the stainless steel or the liquid lithium has been found to accelerate the rate of attack without changing the apparent activation energy. Grain boundary grooving of Armco iron in liquid lithium indicates that the controlling mass transport is also through a corrosion product present as a surface film. Stresses as small as 12 MPa have been found to give rise to a fifty-fold increase in the rate of penetration of Armco iron by liquid lithium.

57134 (CONF-760503—P2, pp 453-461) **Corrosion of iron-base alloys by lithium.** Selle, J.E. (Oak Ridge National Lab., TN). Nov 1976.

From International conference on liquid metal technology in energy production; Champion, Pennsylvania, United States of America (USA) (3 May 1976).

In Proceedings of the international conference on liquid metal technology in energy production.

A review of corrosion mechanisms operating in lithium-iron-base alloy systems is presented along with data obtained with thermal-convection loops of niobium-stabilized 2 ¼ percent Cr-1 percent Mo steel and types 304L and 321 stainless steels. A corrosion rate of 2.3 μm/year (0.09 mil/year) was obtained on the 2 ¼ percent Cr-1 percent Mo steel at 600°C. Considerably more mass transport of alloying constituents and a maximum corrosion rate of about 14 μm/year (0.55 mil/year) was obtained with the austenitic stainless steels. Results of metallography, x-ray fluorescence analysis, scanning electron microscopy, and weight-change data are presented and discussed.

57135 Carburization of centrifugally cast tubes in the petrochemical industry and explanation of this behavior based on laboratory tests on Cr—Ni steels and alloys at 800 and 1150°C. Steinkusch, W. (Pose-Marre Edelstahlwerk, Erkrath, Ger.). *Werkst. Korros.;* **28**: No. 1, 1-6(Jan 1977). (In German).

The tests on tubing used in cracking processes show that heavy carbon pick-up starts above 1050 C, where equilibrium is attained between chromium oxide and carbide, so that the oxide is no longer stable and the original protective effect of the oxide layer is lost. For the same reason, preoxidation may have other than favorable effects, when cracks form in the oxide layer during cooling so that cracking may start at temperatures as low as 800$degree$C. Carburization is delayed by high Cr, Ni, and Si contents; for use at 1100$degree$C, at least 28% Cr, 32% Ni, and 2.5% Si are required.

57136 $2^1/_4$Cr—1Mo steel plate with improved temper embrittlement characteristics. Kanazawa, S. (Nippon Steel Corp., Sagamihara City, Japan); Otoguro, Y.; Horiya, T.; Nakao, H.; Tanaka, N.; Yamaba, R. pp 1003-1010 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

2 1/4 Cr-1Mo steel is widely used for reactor pressure vessels in the direct desulfurization process of heavy oil. Since the operating temperature of these vessels reaches 400-450 C, reduction of temper embrittlement and guaranty of high temperature strength must be considered when producing steels for this use. Two kinds of steel were found to have improved properties after a series of systematic investigation of the effects of alloying elements and impurities on the above requisites. Then, various characteristics of these heavy-section steel plates and their weldments were investigated. These two steels showed remarkable low susceptibility to temper embrittlement and sufficient high temperature tensile strength.

57137 Some questions of high-temperature vanadic corrosion and principal lines of development of heat-resistant materials. Ryabchenkov, A.V.; Maksimov, A.I.; Kuznetsov, E.V. (Cent Sci Res Inst of Heavy Mach, USSR). *Teploenergetika (Moscow);* No. 12, 57-59(Dec 1976). (In Russian).

The main cause of a sharp drop of heat-resisting properties of metallic materials is destruction of protective oxide films by vanadium pentoxide. However, not all the oxides actively react with V_2O_5. Oxides of aluminum, titanium, beryllium and some other metals are able to protect materials up to the temperature of 750°C. Likewise, some systems of oxides of chemical compound type also possess high protective properties. Thus two ways of manufacture of steels and alloys, as well as metal coatings, for operation in the combustion products of high-sulfur-content residual fuel oil present themselves: first, alloying, to obtain oxide films of complex chemical compound type, able to withstand operation in given conditions; secondly, alloying with elements forming oxide films that do not react with V_2O_5. Some examples of possible alloys are given.

57138 Stress-corrosion studies on materials used for surgical implants. Thomas, C.R.; Robinson, F.P.A. (Univ of the Witwatersrand, S Afr). *J. S. Afr. Inst. Min. Metall.;* 77: No. 4, 93-102(Nov 1976).

Samples of Vitallium (a cobalt-chromium alloy), 316L stainless steel, and titanium T318 are subjected to the boiling magnesium chloride test so that their susceptibility to stress-corrosion cracking can be determined, and their behaviour under service conditions is assessed. Stress-corrosion cracking is confined to the stainless-steel samples, while gross pitting is detected in the samples of forged Vitallium. It is concluded that the use of stainless steel should be avoided for long-term surgical implants. Surface imperfections on the stainless steel are generally the cause of pitting, from which stress-corrosion cracks are sometimes propagated.

57139 Materials for advanced high temperature reactors. Graham, L.W. (Flight Refrielling, Wimborne, Engl). *Rev. Int. Hautes Temp. Refract.;* 13: No. 4, 190-203(1976).

The behavior of high-temperature materials used for the construction of the direct-cycle helium gas turbine utilizing process heat from nuclear high-temperature (HTR) reactors is studied. Covered are various available superalloys for turbine blades and vanes, high-temperature ducts and castings, and intermediate heat exchanger tubes. Detailed attention is given to the operational behavior of these materials, with particular emphasis on the effect of temperature and alloy composition on their oxidation and carburization in HTR helium and the effect of environment on their creep strength.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 56653, 56654, 56755, 57125

57140 (AED-Conf—76-556-004) Neutron exposure for safety limitation for reactor pressure vessel steels. Schneider, W. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Zentralabteilung Brennelement- und Bestrahlungstechnologie). 1976. 19p. (In German). (CONF-7609138—). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Technical meeting on radiation exposure and damage of reactor components outside the reactor core; Stuttgart, German, Federal Republic of (F.R. Germany) (23 Sep 1976).

2 tabs.; 18 refs.

The need of improvement in the neutron exposure limitation for reactor pressure vessel steels in the Federal Republic of Germany in metrological view is described. Its consequences from the standpoint of safety technology and of economics are pointed out. Trends in development and international recommendations are reported which are expected to abolish the mentioned deficiencies in the majority. Summarizing three tasks are formulated with respect to the intended improvement: a detailed recommendation for the procedure in radiation damage dosimetry, a test of usefulness by a correlation study for the displacement number per atom as the proposed measuring quantity, and compilation of neutron flux density spectra and damage indices for steel irradiation positions, especially also in nuclear power reactors.

57141 (CONF-770649—1) Low-temperature irradiation of niobium with 15-MeV neutrons. Kerchner, H.R.; Coltman, R.R. Jr.; Klabunde, C.E.; Sekula, S.T. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

From International discussion meeting of radiation effects in superconductors; Argonne, Illinois, United States of America (USA) (13 Jun 1977).

Niobium was irradiated at 4.2°K with high-energy d-Be neutrons to a fluence of 3.7 x 10^{18} n/cm^2. The neutrons were generated at the Oak Ridge Isochronous Cyclotron by the breakup reaction of 40-MeV deuterons in a thick Be target. The resulting neutron energy spectrum was broadly peaked near 15 MeV. The .012-cm-diameter wire sample (RRR = 200) was situated in a uniform transverse magnetic field. The critical current, flux-flow resistance, and normal-state resistance were measured by using a standard four-terminal technique. The critical-current density and flux-flow resistivity were observed to increase with irradiation and to decrease toward the preirradiation values with subsequent isochronal annealing between 4.2°K and 360°K. Using recent theories of flux-line-lattice deformation, we deduce the elementary pinning force and compare the result to theoretical calculations.

57142 (ECN—4) Fast reactor programme; irradiation effects on the mechanical properties of 18Cr-11Ni stainless steel (DIN 1.4948, type AISI 304 ss). First status report. van der Schaaf, B. (ed.). (Stichting Energieonderzoek Centrum Nederland, Petten). Jul 1976. 112p. Dep. NTIS (US Sales Only), PC A06/MF A01.

50 figs., 7 refs., 26 tables.

An extensive programme dealing with irradiation effects on the mechanical properties of the 18Cr-11Ni stainless steel (DIN 1.4948, AISI 304) for the SNR-300 reactor vessel and internal components is in progress. For unirradiated material the number of cycles-to-failure of welded joints, on low-cycle fatigue tested at 823 K, is about half of that of base material. Fusion defects in welded joints result in one sixth of the number of cycles-to-failure measured for base material. Creep strengths of welded joints at 823 K are about 15 MN.m^{-2} lower than those of base material; times-to-rupture of welded joints are about half of those of base material, both in unirradiated condition. The number of cycles-to-failure is halved, from 1580 to 840 cycles, when the strain rate is reduced from 0.0001 to 0.00001/s at 823 K, strain amplitude 1.2%. The strain rate in the range of 0.01% to 1000%/s has little influence on the tensile properties of unirradiated material. Irradiation of welded joints and base material brought about a reduction in the number of cycles-to-failure and a sharp reduction in the creep ductility. Creep strengths are reduced by approx. 45 MN.m^{-2} for base material and by approx. 30 MN.m^{-2} for welded joints. The embrittling effect is brought about by the presence of helium due to thermal neutron interaction with the 3 ppm ^{10}boron isotope in the steel. Low-cycle fatigue conditioning causes considerable reduction in ductility of these materials in reference and irradiated conditions. The elongations, however, are mostly more than 10% for fatigue fractions below 80%.

57143 (UWFDM—184) Systematic approach to the radiation damage problem in fission and fusion reactor structural alloys. Bullough, R.; Eyre, B.L.; Kulcinski, G.L. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). Sep 1976. Contract EY-76-S-02-2272. 29p. Dep. NTIS, PC A03/MF A01.

To assess the suitability of a material for use as a core component in a fast reactor or for the first wall in a fusion reactor, it is necessary to know the irradiation damage behaviour of the material outside the usual materials testing data domain. In the present paper we propose a strategy based on a closely co-ordinated programme of experimental and theoretical research. The aim of this strategy is the systematic construction of a physically based model of the evolving damage structures. This would then allow both the necessary extrapolations of the data to the desired conditions to be achieved in a reliable fashion and provide a rational basis for the development of low swelling alloys for the two nuclear systems.

57144 Short-range order in disordered Fe—Ni alloys investigated by time-dependent perturbed angular correlation technique. Selvatici, E.; Ellis, W.H. (Univ. of Florida, Gainesville). *Trans. Am. Nucl. Soc.;* 26: 149-150(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57145 Effect of implanted interstitials on swelling during self-ion bombardment. Brailsford, A.D. (Ford Motor Co., Dearborn, MI); Mansur, L.K. *Trans. Am. Nucl. Soc.;* 26: 178-179(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57146 Damage profile in molybdenum bombarded with Ni^{++} and (Ni^{++} + He^{+}) ions. Brimhall, J.L.; Henager, C.H. Jr. (Battelle Pacific Northwest Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* **26**: 179(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57147 Depth distribution of damage in ion-bombarded molybdenum. Bradley, E.R.; Brimhall, J.L. (Battelle Pacific Northwest Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* **26**: 179-180(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57148 Momentum transfer and damage energy gradient effects on helium permeability. Choyke, W.J. (Univ. of Pittsburgh); Spitznagel, J.A.; McGruer, J.N. *Trans. Am. Nucl. Soc.;* **26**: 180-181(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57149 Primary recoil energy spectra considerations in ion-bombardment experiments. Spitznagel, J.A. (Westinghouse Research Labs., Pittsburgh); More, R.M.; Choyke, W.J.; Venskytis, F.J. *Trans. Am. Nucl. Soc.;* **26**: 181-182(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57150 Void formation from 200 to 700°C in heavy-ion irradiated vanadium. Weber, W.J.; Kulcinski, G.L.; Smith, H.V. Jr.; Wilkes, P. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.;* **26**: 182-184(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57151 Void swelling in V-ion-irradiated V-O alloys. Agarwal, S.C.; Potter, D.I.; Taylor, A. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 184-185(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57152 Influence of irradiation on copper- and antimony-doped germanium. Belokurova, I.N.; Degtyarev, V.F.; Laptev, A.V.; Skudnova, E.V. (A. A. Baikov Institute of Metallurgy, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Semicond. (Engl. Transl.);* **11**: No. 4, 391-392(Apr 1977).

An investigation was made of the influence of electron irradiation on the electrical properties of p-type germanium doped simultaneously with copper and antimony. The irradiation reduced significantly the hole density. The dose dependences of the hole density and of the donor and acceptor concentrations were determined in the course of irradiation. It was found that a reduction in the hole density was due to the formation of donor centers. Isochronous annealing of the irradiated samples was carried out in the temperature range 20—300°C. The degree of annealing was determined in the range 120—160°C, where partial recovery of the hole density was observed.

57153 Number of Frenkel defects in germanium irradiated with high-energy gamma rays. Ivanov, N.A.; Komarov, S.R.; Kosmach, V.F.; Ostroumov, V.I. (M. I. Kalinin Polytechnic Institute, Leningrad). *Sov. Phys. - Semicond. (Engl. Transl.);* **11**: No. 4, 446-447(Apr 1977).

The number of Frenkel defects formed in germanium by gamma rays of energies up to 40 MeV is calculated allowing for the influence of products of photonuclear reactions.(AIP)

CERAMICS, CERMETS, AND REFRACTORIES

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 55862, 55864, 55870, 55871, 55872, 55874, 55875, 56544, 56726, 57096, 57155

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 56774

57154 (UCRL—13726) Titanium—oxygen system: review of structure, thermodynamics, and phase equilibria. Lam, S.T.; Arulpragasam, I.; Munir, Z.A. (California Univ., Davis (USA). Dept. of Mechanical Engineering). [nd]. Contract W-7405-ENG-48-PO-3775603. 68p. Dep. NTIS, PC A04/MF A01.

A comprehensive review of the literature on the titanium-oxygen system is presented. Emphasis is placed on the structural and thermodynamic consideration for the phases. A discussion of these considerations is presented in terms of numerous possible phase equilibria and property changes.

57155 Structure of chemical vapor deposited silicon carbide. Chin, J.; Gantzel, P.K.; Hudson, R.G. (Gen At Co, San Diego, Calif). *Thin Solid Films;* **40**: No. 1/2/3, 57-72(Jan 1977).

The purpose of the present work was to determine what morphological, chemical and crystal structural changes occur when SiC is deposited at reduced pressures from the pyrolysis of $CH_3SiCl_3+H_2$. SiC is a prime candidate as a fusion first wall material. The behavior of SiC in a fusion first wall environment is meaningful only if one can relate it to known parameters of crystal structure, crystal orientation, stoichiometry and gross morphology. The structural and chemically heterogeneous nature of commercial SiC makes such an evaluation more difficult. CVD-prepared SiC was therefore chosen for this study.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 55565, 56494

57156 (SAND—77-1056C) Measurement of wave profiles in shock-loaded solids. Graham, R.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 33p. (CONF-770706—15). Dep. NTIS, PC A03/MF A01.

From 6. AIRAPT international high-pressure conference; Boulder, Colorado, United States of America (USA) (25 Jul 1977).

The evolution of the numerous detectors which measure wave profiles in solids subjected to rapid impulsive loading is traced and principal trends are identified. Recent capabilities for the measurement of transverse or higher-order motions (acceleration and velocity gradient) are described. 6 figures, 2 tables, 35 references.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 55565, 55573, 55867, 56707, 56722, 56838, 56878, 57096

57157 (AERE-M/R—1746) Wetting properties of solid oxides and carbides by liquid metals. Livey, D.T.; Murray, P. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). 16 Sep 1955. 46p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Experiments have been carried out on the wetting properties of solid oxides and carbides by liquid metals and an estimation has been made of the surface energy of UO_{2-0} and of the refractory monocarbides. The results indicate that, in the absence of chemical reaction, oxide surfaces are only wetted by metals of low atomic number. The suggestion is made that this is due to an attraction existing between the positive nucleus of the metal and the negatively charged anions of the oxide surface. Conversely non-wetting by metals of higher atomic numberis due to repulsion between the negative surface and the electron cloud of the metal. Carbides are more readily wetted by liquid metals because of the different nature of the carbide surface, this being dominated by the metal atoms and not as in oxides, by negative anions. Carbides of high surface energy have then a low interfacial tension with liquid metals and hence good wetting properties. For the application of liquid metals to nuclear reactors in which refractory uranium compounds are suspended in the liquid metal, wetting is essential. Uranium oxide (UO_2) and uranium carbide are readily wetted by liquid sodium at 400°C. Bismuth, of special importance because of its low capture cross section, is non-wetting to oxide and carbide. The addition of 0.3 percent nickel lowers the wetting temperature in the Bi approximately UC system in vacuo from 700°C to 580°C. Coating of the carbide particles with silver also promotes wetting by bismuth.

57158 Significant differences between Hartree-Fock and local-exchange energy bands for TiO. Jennison, D.R.; Kunz, A.B. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Phys. Rev. Lett.;* **39**: No. 7, 418-421(15 Aug 1977).

Hartree-Fock (HF) energy-band calculations on TiO are in qualitative disagreement with those obtained with use of statistical exchange ($X\alpha$). While all $X\alpha$ results have a 2—8-eV gap between the Ti 3d and O 2p bands, the HF results show largely overlapping 2-ip-3d bands. The HF result is supported experimentally by the absence of any gap in the experimental valence x-ray—photoemission—spectroscopy spectrum. Reasons for the apparent failure of $X\alpha$ theory on this material, and not on other materials, are suggested.

57159 Optical absorption of vanadium pentoxide in the energy range 1.0—5.5 eV. Dorozhko, E.V.; Savitskii, V.G. (Ivan Franko

State University, Lvov). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 4, 555-557(Apr 1977).

The spectral dependence of the optical absorption coefficient of V_2O_5 in the photon energy range 1.0—5.5 eV is derived from measurements of the transmission of films of different thicknesses. The observed features of the absorption curve are interpreted as electronic transitions between narrow bands associated with the $3d^2$ terms of the vanadium ion, which are split by the octahedral symmetry of the field due to the nearest neighbors.

57160 Optical absorption of VO_2 and V_2O_3 films and ability to predict semiconductor—semimetal phase transitions in transition metal compounds. Dorozhko, E.V.; Savitskii, V.G. (I. Franko State University, Lvov). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 4, 669-670(Apr 1977).

The optical absorption spectra of VO_2 and V_2O_3 films were studied using the two-thickness method at room temperature. The experimental results are explained in terms of transitions between energy bands formed by terms of the V^{3+} ion.(AIP)

57161 Electrochromism in V_2O_5 films. Gavrilyuk, A.I.; Chudnovskii, F.A. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 2, 69-70(Feb 1977).

V_2O_5 films were produced by thermal evaporation of powdered V_2O_5 in a vacuum. These films were deposited on a glass substrate and, with water as the electrolyte, electrochromism was observed. It is concluded that the electrochromism was due to the formation of hydrogen-vanadium bronzes.(AIP)

57162 Pinning in niobium and vanadium single crystals containing hydrogen. Vinnikov, L.Y.; Zharikov, O.V.; Kopetskii, C.V.; Polovov, V.M. (Institute of Solid State Physics, Academy of Sciences of the USSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **3**: No. 1, 4-8(Jan 1977).

The critical current density (J/sub c/), the volt—ampere characteristic (VAC) and the pinning force F/sub p/ are investigated in Nb and V single crystals containing hydrogen. The temperature of hydride phase formation during cooling and the hydrogen concentration were determined by calorimetry. A significant increase in J/sub c/ as well as a change in the VAC shape were detected after abrupt cooling of the specimens from 295 to 4.2°K. The results are discussed under the assumption of vortex pinning by hydride precipitates.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 55565

57163 (N—77—16115) **Oxidation behavior of nickel—chromium—aluminum—yttrium — magnesium oxide and nickel—chromium—aluminum—yttrium — zirconate type of cermets.** Zaplatynsky, I. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Dec 1976. 18p. (NASA-TM-X—3466; E—8834). NTIS PC A02/MF A01.

The 1100 and 1200 C cyclic oxidation resistance of dense Ni-Cr-Al-Y - MgO, Ni-Cr-Al-Y - $CaZrO_3$, Ni-Cr-Al-Y - $SrZrO_3$, Ni-Cr-Al-Y - $MgZrO_3$ cermets and a 70 percent dense Ni-Cr-Al-Y developmental material was determined. The cermets contained 60 and 50 volume percent of Ni-Cr-Al-Y which formed a matrix with the oxide particles imbedded in it. The cermets containing MgO were superior to cermets based on zirconates and to the porous Ni-Cr-Al-Y material. Cyclic oxidation tests of four cermet systems are reported; variables include simple oxide content, element content, oxidation temperature, specific weight change, number of cycles, and X-ray diffraction pattern intensities: 2 figures and 3 tables include numeric data.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 56475

COMPOSITE MATERIALS

PREPARATION AND FABRICATION

57164 (LA-UR—77-1261) **Chemical vapor deposition of tantalum on graphite cloth for making hot pressed fiber reinforced carbide-graphite composite.** Hollabaugh, C.M.; Davidson, K.V.; Radosevich, C.L.; Riley, R.E.; Wallace, T.C. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 18p. (CONF-771004—1). Dep. NTIS, PC A02/MF A01.

From 6. international conference on chemical vapor deposition; Atlanta, Georgia, USA (10 Oct 1977).

Conditions for the CVD of a uniform coating of Ta on fibers of a woven graphite cloth were established. The effect of gas composition, pressure, and temperature were investigated, and the conditions that gave the desired results are presented. Several layers of the coated cloth were hot pressed to produce a TaC—C composite having uniformly dispersed, fine-grained TaC in graphite. Three compositions were hot pressed: 15, 25, and 40 volume percent carbide. 8 figures, 2 tables.

57165 (ORNL-tr—4356) **Study of a method of accelerated hardening of concrete by microwaves.** Darcemont, M.; Bresson, J. Translated by R.G. Mansfield from *Betons Ind.;* **49**: 19-30(1975). 17p. Dep. NTIS, PC A02/MF A01.

The present study shows that the application of heat by means of centimetric waves produces rapid hardening of various types of concrete. The results prove that it is possible by this process to obtain within two hours a strength which may reach 50% of the 28-day strength of the reference concrete kept under normal conditions.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 57107

57166 (LA-tr—77-26) **Pressing of cement pastes, as well as the possibilities of utilizing this method for the purpose of determination of the quality of the cement.** Gaca, W. 1977. Translated from Zesz. Nauk. Politech. Gdansk., Budownictwo Ladowe IV; No. 25, 9-34(1961). 31p. Dep. NTIS, PC A03/MF A01.

A fast method for determining cement quality is proposed. The method allows determination of cement type within 6 hours without thermal treatment. Mechanical pressure is used to speed hydration and hardening. (GHT)

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 57252

57167 (R—1979-AF) **Advanced composites: electromagnetic properties, vulnerabilities, and protective measures.** Hiebert, A.L. (Rand Corp., Santa Monica, Calif. (USA)). May 1977. 55p. Santa Monica, CA.

A measurement and analysis program for assessing the electromagnetic (EM) properties and vulnerabilities of, and protective measures for, advanced composite materials for aerospace vehicles is discussed. The main purpose of the report is to suggest areas of investigation and the kinds of data required to compile a technical data base to accomplish this assessment. Instrumentation and techniques are needed that will provide some standard procedures for measuring and analyzing fundamental EM parameters. It was found that, compared with metals, nonmetallic composites have low conductivity and large variations in EM parameters; these are due to wide differences in materials, manufacturers' fabrication techniques, and structural composition. Whenever nonmetallic composites are used or substituted for metals, it is essential that the inherent EM properties be identified, analyzed, re-engineered, and reestablished to meet EM functions and specifications as required. Several workshops on the EM hazards associated with advanced composite airframe structures were conducted. New and/or additional protective EM shielding will be required on aerospace vehicles, on communications and electronic equipment, and on sensitive digital avionics equipment and components to protect them from hazards such as electromagnetic pulse (EMP), lightning, static electricity, electromagnetic interference, and other extraneous EM energy. Electrical integrity and continuity for grounding, bonding, and power returns will require attention. The several orders of magnitude of EM shielding attenuation and electrical continuity provided by metal housings, enclosures, and structures may be substantially reduced by using composites. 5 figures, 4 tables.

57168 Optical properties of selectively absorbing Ni/Al_2O_3 composite films. Craighead, H.G.; Buhrman, R.A. (School of Applied and Engineering Physics and Materials Science Center, Cornell University, Ithaca, New York 14853). *Appl. Phys. Lett.;* **31**: No. 7, 423-425(1 Oct 1977).

Composite films of Ni particles embedded in an Al_2O_3 matrix have been produced by controlled coevaporation. The optical properties of the Ni/Al_2O_3 composites measured over the range of the solar spectrum are in good accord with the predictions of Maxwell-Garnett theory provided the Ni volume fraction is $<$ or approx. $=0.2$. The composite films have excellent spectral selectivity for the absorption of solar radiation, with a solar absorptivity of 0.94 obtained for a film produced with a composition gradient. Low-temperature emissivities of $\sim$ 0.1 have been obtained with composite films evaporated on highly reflecting metal substrates.

57169 Effective medium theory of optical properties of small particle composites. Wood, D.M.; Ashcroft, N.W. (Cornell Univ, Ithaca, NY). *Philos. Mag.;* **35**: No. 2, 269-280(Feb 1977).

A self-consistent field approach for the calculation of optical properties of a random n-component medium composed of discrete

small particles is applied to an insulator-metal mixture for the case of metal formed into small spheres. The real part of the resulting conductivity exhibits broad surface plasmon absorption and a zero-frequency percolation conductivity. These results are contrasted with those of the Maxwell-Garnett theory for the effective composite conductivity. The effects of an insulating coat on the response of the metal particles are examined and shown to produce profound effects at low frequency. Modifications introduced by a distribution of particle sizes are examined, and a completely self-consistent form of the mean field equations for an n-component system, each of whose constitutents is distributed in size, is proposed.

POLYMERS AND PLASTICS

PREPARATION AND FABRICATION

57170 (GEPP—305) **Polyurethane elastomer system.** Creed, K.E. (General Electric Co., St. Petersburg, Fla. (USA). Neutron Devices Dept.). 15 Jul 1977. Contract EY-76-C-04-0656. 15p. Dep. NTIS, PC A02/MF A01.

The OSHA restrictions on the use of 4,4'-methylenebis (2-chloroaniline) for curing urethanes resulted in the use of a recently developed system based on a mixed aliphatic/aromatic polyol curative. However, continued evaluation of this system evidenced substantial lot-to-lot and inter-laboratory variations in shear modulus data. This was initially attributed to moisture pickup and/or aging but further tests indicated a stoichiometry problem. Normally with an amine cured urethane, the amount of curative used is only 95 percent of that required to react with all of the isocyanate groups (0.95 to 1 ratio). Shear modulus data indicated that for the polyol system, a 1 to 1 OH/NCO ratio was needed to provide consistent properties. Since previous test data had not evidenced this variability, a program was initiated to assess the stoichiometric effects in greater detail. In addition to the polyol curative evaluation, six urethane systems that do not contain 4,4'-methylenebis (2-chloroaniline) were assessed for tensile strength, elongation and tear strength.

57171 **Substituting polyketones and polysulfones for polyethylene.** Steinberg, M. (Brookhaven Natl Lab, Upton, NY). *Chem. Eng. Prog.;* 72: No. 9, 75-79(Sep 1976).

It appears appropriate, from a conservation point-of-view to make a study of the ethylene-CO and ethylene-SO_2 copolymer systems. The possible savings in gas and oil reserves by substituting an essentially low cost waste product, such as CO or SO_2, coupled with a high commodity U.S. and world market for polyethylene, presents a strong incentive for pursuing the required development effort. Thorough investigation of the possibility of a low temperature catalytic process must be made. Design of the radiation chemical reactor is an important problem requiring detailed design analysis. Of major importance, enough polysulfones and polyketones must be produced in bench or pilot scale equipment for the purpose of determining its processability and its market acceptance. 6 refs.

57172 **Investigation of the process of extrusion of medium-pressure polyethylene-based tubes in connection with the prospect of their utilization in Azerbaijan oil industry.** Buniyat-Zade, A.A.; Kakhramanov, N.T.; Bilalov, Ya.M.; Faruki, F.I. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 99-101(1976). (In Russian).

On the basis of the results of an investigation of viscosity-flowrate and volumetric characteristics of medium pressure polyethylene (MPPE) and its stabilized composition, it is found that introduction of N, N'diβ-naphthyl-n-phenylenediamine helps to lower considerably the viscosity of the polymer melt and to increase its rate of crystallization. The process of extrusion of MPPE into tubes is studied. It is shown that stabilizer permits processing of MPPE within a fairly wide range of temperatures and extrusion rates.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 57170

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 56686

57173 (SAND—76-5854C) **Organics used in microelectronics: a review of outgassing materials and effects.** Traeger, R.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 13p. (CONF-770513—3). Dep. NTIS, PC A02/MF A01.

From Electronic component conference; Arlington, Virginia, United States of America (USA) (17 May 1977).

Versatility, ease of application, and low cost make organic materials attractive for adhesive bonding, chip die down, and coatings for microelectronic systems. However, negative past experiences and lack of knowledge about the organic materials have raised many concerns; one concern being the effect of outgassing materials on devices and interconnections. This paper documents some of the concerns, briefly reviews the chemistry of organics commonly used with respect to possible detrimental materials, summarizes the outgassing data obtained at Sandia and that reported in the literature, and makes recommendations for the selection and application of organic materials. The results show that outgassing need not be a concern if materials are chosen carefully and processed under conditions used for handling the other parts of microcircuits. Water and carbon dioxide, the major contaminants, are absorbed in the organics from the environment during handling or storage.

OTHER MATERIALS

REFER ALSO TO CITATION(S) 56927

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 55862, 56902, 57176

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 57102

57174 (COO—2899-1) **Influence of grain boundaries on the electrical transport properties of polycrystalline Si films. Progress report.** Ast, D.G. (Cornell Univ., Ithaca, N.Y. (USA). Dept. of Materials Science and Engineering). 1977. Contract E(11-1)-2899. 7p. Dep. NTIS, PC A02/MF A01.

Preliminary high resolution TEM of grain boundaries and twin boundaries in polycrystalline Si has shown that the grain boundaries may have very complicated structures. In two cases, complete spatial orientation of adjacent grains (i.e., including determination of the translation vector in the boundary) has been carried out, using the method of common reflection and lattice imaging techniques.

57175 (SAND—77-0104C) **Some applications of high pressure studies of phase transitions in solids.** Samara, G.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 35p. (CONF-770706—13). Dep. NTIS, PC A03/MF A01.

From 6. AIRAPT international high-pressure conference; Boulder, Colorado, United States of America (USA) (25 Jul 1977).

A review is presented of the most unique applications of pressure-induced phase transitions in solids, namely that of shock-wave-actuated pulse power devices employing either ferromagnetic or ferroelectric materials. The principles of operation of these devices is reviewed and some of the associated materials properties and phase transitions are discussed. (GHT)

57176 **Shrinkage of rod-shaped defects in boron-ion-implanted silicon.** Wu, W.; Washburn, J. (Department of Materials Science and Engineering and Materials and Molecular Research Division of the Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Appl. Phys.;* 48: No. 9, 3742-3746(Sep 1977).

Three different types of rod-shaped defects formed during postimplantation annealing of boron-implanted silicon are distinguished in annealing experiments carried out on transmission electron microscope specimens. It is shown that rod-shaped defects can be boron precipitates, Frank dipoles, or perfect a/2 <110< dipoles. All shrink from the ends only during annealing. The temperature dependence of shrinkage rate for the first type was determined by measuring dL/dt at three different temperatures for a given isolated defect. Boron diffusion appeared to be the rate-determining process. The second type, Frank dipoles, were often observed to unfault, transforming into the third type during annealing. At the time of unfaulting the newly formed perfect dipole was always observed to rotate on its glide cylinder to near edge orientation.

57177 **Climb of dislocations in boron-ion-implanted silicon.** Wu, W.; Washburn, J. (University of California, Berkeley, Berkeley, California 94720). *J. Appl. Phys.;* 48: No. 9, 3747-3751(Sep 1977).

The climb of dislocations, both perfect [b= (1/2) <100<] and imperfect [b= (1/3) <111<], was studied in boron-implanted silicon thin foils by electron microscope observation of the shrinkage of interstitial-type dislocation loops. The temperature dependence of the climb rate gave an apparent activation energy of 5.6 +- 0.5 eV for both types. The imperfect loops adopted a rounded shape during shrinkage but tended to acquire straight segments whenever the climb motion required nucleation of new jog pairs. Climb rate at a given temperature was shown to be a function of the climb force on the dislocation and on the distance to the nearest efficient sink or source. The surfaces of the foil were shown to be relatively poor sinks for interstitials or alternatively poor sources for vacancies.

PROPERTIES

REFER ALSO TO CITATION(S) 55650, 56427, 56902

57178 Photoluminescence of hydrogenated amorphous silicon. Pankove, J.I.; Carlson, D.E. (RCA Laboratories, Princeton, New Jersey 08540). *Appl. Phys. Lett.;* **31**: No. 7, 450-451(1 Oct 1977).

Amorphous silicon obtained by the glow-discharge decomposition of silane can contain on the order of 18—50 at.% of hydrogen. Heating this material above 350°C causes the evolution of H_2. The photoluminescence efficiency decreases with increasing hydrogen depletion.

57179 Optical properties of trivalent chromium in silicate glasses: A study of energy levels in the crossing region. Brawer, S.A.; White, W.B. (Materials Research Laboratory, The Pennsylvania State University, University Park, Pennsylvania 16802). *J. Chem. Phys.;* **67**: No. 5, 2043-2055(1 Sep 1977).

A theoretical and experimental study of the optical properties of trivalent chromium in silicate glasses is described. New experimental results presented are (1) the temperature dependence of the absorption, (2) determination of the dependence of emission on the excitation frequency, (3) determination of the ^2E $^4A_2$ emission. These results are interpreted in terms of the structure of the Cr^{3+} sites in the glasses. Of theoretical interest is the fact that, for Cr^{3+} in silicate glasses, Dq is in the crossing region of the $^4T_2$ and $^2T_1$ levels which interact strongly by spin—orbit coupling. To explain the absorption line shape of such systems, it is necessary to include vibronic effects. Calculations of the absorption are made and compared with experiment.

57180 High-temperature thermal conductivity of La_3Te_4. Luguev, S.M.; Smirnov, I.A. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 4, 707-708(Apr 1977).

The total thermal conductivity, electric resistivity, and thermoelectric power of Laztey were measured in the temperature range 80—750K.(AIP)

CORROSION, EROSION, AND DEGRADATION

57181 (LA-UR—77-1098) **Fundamental statistical methods in particle science.** Lewis, H.D. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 13p. (CONF-770520—2). MF A01.

From International powder and bulk solids handling and processing conference/exhibition; Rosemont, Illinois, United States of America (USA) (May 1977).

An attempt is made to develop the small particle statistics as a natural evolution from basic statistical concepts. It is indicated that tests of statistical hypothesis were possible for "goodness of fit" and comparisons of mean and variance respectively for particle "size" data of the type n/sub i//N vs. "size." However, the methods of statistical inference do not apply to weight fraction or general moment data in a neat, clearcut manner. This is because the test statistic distributions have not been defined for Type II or k/sup th/ order moment data. Sample data comparisons for moment data must in general be based on subjective analysis tempered by a good portion of practical experience. It is shown that all forms of particle "size" data can be classified as one of two general types, and that such classification directly relates data forms generated by a particular measurement method with the proper mathematical treatment of the data.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 56727

57182 (NP—22108) **Damage profiles in silicon and their impact on device reliability. Technical report number 1, October 15, 1976—March 30, 1977.** Schwuttke, G.H. (International Business Machines Corp., Hopewell Junction, N.Y. (USA). East Fishkill Lab.). [nd]. 44p. Business Machines Corporation, Hopewell Junction, NY.

N-type Si was implanted with 200 keV Cs^+ with doses ranging from 10^{13} to 10^{15} ions/cm^2. After nitrogen anneal MOS capacitors were formed by thermal oxidation and Al deposition. Transmission electron microscopy was used to study the residual ion damage. A high density of vacancy clusters of 10 to 40 A is observed. In addition circular stacking faults are found in the region of the Cs profile peak. Through MOS capacitance measurements a reduction of minority carrier lifetime by a factor of 10^5 was found. This is caused by the Cs distribution in the Si which is stable at high temperature treatments as confirmed by SIMS measurements.

57183 Direct observation of the dynamics of picosecond-pulse optical breakdown. Anthes, J.P.; Bass, M. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Appl. Phys. Lett.;* **31**: No. 7, 412-414(1 Oct 1977).

The dynamics of electron avalanche breakdown induced by picosecond laser pulses were observed directly with an ultrafast streak camera. The ionization rate for fused quartz exposed to a 25-psec 532-nm pulse which produced a damaging breakdown is $< \text{or} = 4.5 \times 10^{12}\ \text{sec}^{-1}$.

57184 System for controlling ion implantation dosage in electronic materials. Shifrin, G.A. (to Hughes Aircraft Co.). US Patent 4,021,675. 3 May 1977. Filed date 2 Jan 1975. 10p.

Disclosed is an ion implantation process control system wherein the ion dosage in semiconductor wafers is continuously controlled. This control is achieved by controllably and incrementally integrating the ion beam current to provide a control signal, and then utilizing this control signal to provide controlled relative movement between the ion beam and the surface area upon which it fails. 3 figures

57185 Characteristics of defect formation in Si subjected to large neutron doses. Temper, E.M. *Sov. Phys. - Semicond. (Engl. Transl.);* **11**: No. 4, 453-454(Apr 1977).

Irradiation (at ~50°C) of n- and p-type Si with neutrons in doses of 5×10^{17}—5×10^{19} cm^{-2} produced type A clusters (mainly divacancies) and type B clusters (six or more vacancies).

57186 Amorphization of silicon by bombardment with oxygen ions of energy below 5 keV. Zhukovskii, P.V.; Stel'makh, V.F.; Tkachev, V.D. (V. I. Lenin Belorussian State University, Minsk). *Sov. Phys. - Semicond. (Engl. Transl.);* **11**: No. 4, 466-467(Apr 1977).

Silicon was bombarded with $^{16}O^+$ ions of 1.0 and 3.0 keV energies at room temperature. This bombardment created point defects which joined up to form amorphous layers about 100 A thick. (AIP)

57187 Formation and dissociation of F centers in a KCl crystal as a result of pulsed irradiation. Aluker, E.D.; Gavrilov, V.V.; Chernov, S.A. (Institute of Physics, Academy of Sciences of the Latvian SSR, Salaspils). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 4, 700-701(Apr 1977).

The method of pulse absorption spectroscopy is used to study the temperature dependence of the formation and dissociation of F centers in KCl in the range 100—500°K. The irradiation was by 5-MeV electrons.(AIP)

57188 Influence of temperature on the accumulation and properties of radiation damage in gallium arsenide under electron irradiation. Sirota, A.N.N.; Kurilovich, N.F.; Gatel'skii, G.V. (Institute of Physics of Solid State and Semiconductors, Academy of Sciences of the Belorussian SSR, Minsk). *Sov. Phys. - Dokl. (Engl. Transl.);* **22**: No. 2, 93-95(Feb 1977).

The temperature dependence of the extrinsic photoconductivity of GaAs irradiated with 28 MeV electrons is determined. The temperature range 20-300°C is considered, and the results of isochronous annealing are reported.(AIP)

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 57355

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 55857

57189 (SAND—77-0366C) **Use of $^{12}C(d,p)^{13}C$ and $^{16}O(d,p)^{17}O$ reactions.** Borders, J.A.; Harris, J.M. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 20p. (CONF-770642—4). Dep. NTIS, PC A02/MF A01.

From 3. international conference on ion beam analysis; Washington, District of Columbia, United States of America (USA) (27 Jun 1977).

The use of nuclear reactions for depth profiling carbon and oxygen in solids is discussed. A general expression for the yield from a nuclear reaction is derived and used to extract depth profiles from the energy spectra by two methods. The first method compares data from a target of unknown composition with a target containing a known concentration of either carbon or oxygen. By dividing the yields from the samples for equal collision energies, a concentration profile within the analyzed sample can be obtained. The second method uses published reaction cross section data to obtain the profile. The (d,p) profiling is demonstrated for carbon in ScD_2. A comparison between the two methods is made by extracting carbon profiles in the near surface region of ScD_2 samples. Effects due to inaccurate stopping cross section data are described. The technique is discussed for the $^{16}O(d,p)$ reactions used to profile oxygen along

with the effect of interferences from the $^{2}H(d,p)^{3}H$ reaction and other reactions.

57190 (SAND—77-0424C) **Low concentration oxygen depth profiling by the $^{16}O(d,\alpha)^{14}N$ reaction.** Picraux, S.T. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 20p. (CONF-770642—5). Dep. NTIS, PC A02/MF A01.

From 3. international conference on ion beam analysis; Washington, District of Columbia, United States of America (USA) (27 Jun 1977).

The $^{16}O(d,\alpha)^{14}N$ nuclear reaction is used for depth profiling low levels of ^{16}O by means of energy analysis of the emitted α-particles. The analytic method for converting the emitted α-spectra to concentration vs depth profiles is presented and the technique is applied to a variety of thin film structures. Experimental methods for enhancing the depth resolution and sensitivity are discussed, and depth resolutions of 130 A and sensitivities of 0.3 at. percent are demonstrated.

57191 **Prompt-neutron activation analysis: applications to coal analysis.** Gozani, T. (Science Applications, Inc., Palo Alto, CA); Elias, E.; Orphan, V.; Reed, J.; Shreve, D. *Trans. Am. Nucl. Soc.;* **26**: 160-161(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57192 **Coal composition by ^{252}Cf neutrons and flux level corrections.** Duffey, D. (Univ. of Maryland, College Park); O'Fallon, N.; Porges, K.G.; Armani, R.J.; Wiggins, P.F. *Trans. Am. Nucl. Soc.;* **26**: 161-162(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57193 **Determination of oxygen in reactive materials by 14-MeV neutron activation analysis.** Strain, J.E.; DeVan, J.H. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 167(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 55830, 57199

57194 (LA—6883-MS) **Coulometer operator's manual.** Criscuolo, A.L. (Los Alamos Scientific Lab., N.Mex. (USA)). Jul 1977. Contract W-7405-ENG-36. 20p. Dep. NTIS, PC A02/MF A01.

The coulometer control system automates the titration of uranium and plutonium as performed by the CMB-1 group. The system consists of a printer, microcontroller, and coulometer, all of which are controlled by an algorithm stored in the microcontroller read-only memory. This manual describes the titration procedure using the coulometer control system, its theory and maintenance.

57195 (RDT-C—8-8T(7-77)) **Specimen equilibration device (or multipurpose sampler) for the analysis of nonmetals in liquid sodium.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Development and Demonstration). Jul 1977. Contract EY-76-C-14-2170. 24p. .

This standard establishes the requirements for the design, materials, fabrication, quality assurance, examination, and acceptance testing of an equilibration and sampling device and auxiliary equipment for service in radioactive or nonradioactive liquid sodium. (DLC)

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 57374

57196 (GJBX—43(77)) **Uranium, thorium, and potassium content of Precambrian rocks, Upper Peninsula of Michigan and northern Wisconsin. Supplement to GJBX—48(76). Uranium and thorium occurrences in Precambrian rocks, Upper Peninsula of Michigan and northern Wisconsin, with thoughts on other possible settings.** Kalliokoski, J. (Michigan Technological Univ., Houghton (USA). Dept. of Geology and Geological Engineering). Feb 1977. Contract EY-76-C-13-1651. 42p. Dep. NTIS, PC A03/MF A01.

The method of analysis used in determining U, Th, and K contents of rocks is described, and the results are presented. (LK)

57197 (LA—6869) **Automated energy-dispersive x-ray determination of trace elements in stream sediments.** Hansel, J.M.; Martell, C.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 12p. Dep. NTIS, PC A02/MF A01.

Nickel, copper, tungsten, lead, bismuth, niobium, silver, cadmium, and tin are determined in stream sediments using a computer-controlled energy-dispersive x-ray fluorescence system. The system consists of an automatic 20-position sample changer, a silicon lithium-drifted detector, a pulsed molybdenum transmission-target x-ray tube, a multichannel analyzer, and a minicomputer. Samples are analyzed as minus 325-mesh powders. A computer program positions the samples, unfolds overlapping peaks, determines peak intensities for each element, and calculates the ratio of the intensity of each peak to that of the molybdenum Kα Compton peak. Concentrations of each element are then calculated using equations obtained by analyzing prepared standards. Detection limits range from 5 ppM for silver, cadmium, lead, and bismuth to 20 ppM for niobium. The relative standard is 10 percent or less at the 100-ppM level and 20 percent at the 20-ppM level. Samples can be analyzed at the rate of sixty per day.

57198 (LA—6869-MS) **Automated energy-dispersive x-ray determination of trace elements in stream sediments.** Hansel, J.M.; Martell, C.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1977. Contract W-7405-ENG-36. 10p. (GJBX—52(77)). Dep. NTIS, PC A02/MF A01.

Nickel, copper, tungsten, lead, bismuth, niobium, silver, cadmium, and tin are determined in stream sediments using a computer-controlled energy-dispersive x-ray fluorescence system. The system consists of an automatic 20-position sample changer, a silicon lithium-drifted detector, a pulsed molybdenum transmission-target x-ray tube, a multichannel analyzer, and a minicomputer. Samples are analyzed as minus 325-mesh powders. A computer program positions the samples, unfolds overlapping peaks, determines peak intensities for each element, and calculates the ratio of the intensity of each peak to that of the molybdenum Kα Compton peak. Concentrations of each element are then calculated using equations obtained by analyzing prepared standards. Detection limits range from 5 ppM for silver, cadmium, lead, and bismuth to 20 ppM for niobium. The relative standard is 10 percent or less at the 100-ppM level and 20 percent at the 20-ppM level. Samples can be analyzed at the rate of sixty per day.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 55827, 57232, 57237

57199 (ARH-ST—131) **Determination of aluminum by four analytical methods.** Hanson, T.J.; Smetana, K.M. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Nov 1975. Contract EY-76-C-06-2130. 29p. Dep. NTIS, PC A03/MF A01.

Four procedures have been developed for determining the aluminum concentration in basic matrices. Atomic Absorption Spectroscopy (AAS) was the routine method of analysis. Citrate was required to complex the aluminum and eliminate matrix effects. AAS was the least accurate of the four methods studied and was adversely affected by high aluminum concentrations. The Fluoride Electrode Method was the most accurate and precise of the four methods. A Gran's Plot determination was used to determine the end point and average standard recovery was 100% +- 2%. The Thermometric Titration Method was the fastest method for determining aluminum and could also determine hydroxide concentration at the same time. Standard recoveries were 100% +- 5%. The pH Electrode Method also measures aluminum and hydroxide content simultaneously, but is less accurate and more time consuming that the thermal titration. Samples were analyzed using all four methods and results were compared to determine the strengths and weaknesses of each. On the basis of these comparisons, conclusions were drawn concerning the application of each method to our laboratory needs.

57200 (BNL—22811) **Thermoluminescence, a method for determining the date at which a ceramic object was fired.** Sayre, E.V. (Brookhaven National Lab., Upton, N.Y. (USA)). [nd]. Contract EY-76-C-02-0016. 33p. (CONF-770446—1). Dep. NTIS, PC A03/MF A01.

From Conference on detection of forgery in the arts; Philadelphia, Pennsylvania, United States of America (USA) (27 Apr 1977).

The theory on which thermoluminescence dating of archeological ceramic objects is based and the measurement methods used are outlined. Separation of fine grain particles and quartz particles permits the determination of the thermoluminescence of each and often a more accurate age determination. The application of the method to the dating of a bronze horse from the Metropolitan Museum is described. (JSR)

57201 (CONF-770332—1) **New portable centrifugal fast analyzer with expanded versatility.** Mrochek, J.E.; Burtis, C.A.; Johnson, W.F.; Bauer, M.L.; Lakomy, D.G.; Genung, R.K.; Scott, C.D. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 45p. Dep. NTIS, PC A03/MF A01.

From 9. annual symposium on advanced analytical concepts for the clinical laboratory; Oak Ridge, Tennessee, United States of America (USA) (18 Mar 1977).

Developments in solid-state electronics have resulted in the fabrication of a prototype portable instrument with expanded analytical versatility and the capability to operate from 110 V ac or a rechargeable battery pack. The analyzer, contained in an 18 x 11 x 12-in. box and weighing 55 lb, utilizes a self-contained microprocessor to control a number of analyzer functions as well as to perform data acquisition and analysis. Hardcopy output is produced by an integral thermal printer. A number of analysis options are available including determination of reaction rate by linear regression analysis. Temperature control is maintained at one of three set points (25, 30, or 37°C) by means of a thermoelectric heat pump located in the rotor holder. A clutch-brake assembly incorporated in the rotor drive system enables the rotor to be accelerated to 80 percent of run speed within 100 ms. Utilization of a parallel-channel rotor and a high-resolution, 2 MHz clock enables reactions to be monitored within 100 ms of solution transfer. A maximum of 99 observations may be acquired at variable intervals, the minimum being 1 observation per revolution at 4000 rpm (one observation consists of measurements of dark current and transmission or fluorescence signals from 17 cuvets). The drive system, rotor speed, and the clutch-brake are controlled by the microprocessor and automatically synchronized with data acquisition. Other analyzer operations currently under control of the microprocessor include the selection of preamplifier gain, transmission filters, and primary and secondary filters for fluorescence. The system is described and its various analytical capabilities are evaluated.

57202 (GAT-T—2657) **Analytical capability of the uranium hexafluoride mass spectrometer.** Kauffman, G.F. (Goodyear Atomic Corp., Piketon, Ohio (USA)). 27 Jun 1977. Contract EY-76-C-05-0001. 5p. (CONF-770575—3). Dep. NTIS, PC A02/MF A01.

From 25. annual conference on mass spectrometry and allied topics; Washington, District of Columbia, USA (29 May 1977).

The UF_6 mass spectrometer is an indispensable instrument at the gaseous diffusion plants where vast quantities of UF_6 are processed and thousands of uranium isotopic determinations must be made every month. The electron impact ion source permits rapid exchange of samples and the dual collector provides a rapid and precise measurement of the ratio of two ion currents. The analyses are six-entry relative analyses in which the readings obtained on a sample having unknown isotopic composition are compared to readings obtained on an isotopic standard or to readings obtained on two bracketing standards. About 12 minutes are required for a determination and the analytical precision is such that the relative standard deviation of a single determination is +-0.05 percent or better. However, the mass spectrometer readings are biased. In the literature the bias is blamed on sample interaction or "memory." In this discussion, the nonlinearity of the relationship between the mass spectrometer ratio reading and the isotopic mole ratio of the sample is shown to be responsible for the major portion of the bias, while sample interaction, amplifier zeros, secondary electron emission, and the beam width also influence the magnitude of the bias.

57203 (LA—6867) **Evaluation of the LASL automated spectrophotometer for uranium determination at submilligram levels.** Hollen, R.M.; Jackson, D.D.; Rein, J.E. (Los Alamos Scientific Lab., N.Mex. (USA)). Jul 1977. Contract W-7405-ENG-36. 5p. Dep. NTIS, PC A02/MF A01.

The LASL automated spectrophotometer, designed for determination of 1 to 14 mg of uranium and 0.5 to 14 mg of plutonium, has been evaluated for determination of lower levels of uranium to 0.12 mg. The essentially linear response of absorbance is maintained and the standard deviation for a single measurement is constant at about 0.013 mg of uranium, corresponding to a maximum uncertainty of about 10 percent at the 0.12-mg limit. The instrument was applied to the analysis of a series of low-level-concentration, 0.07- to 0.8-mg/ml uranium samples. The results were not statistically different from those obtained by a manual spectrophotometric method.

57204 (RFP-Trans—225) **Determination of total beryllium in soils by atomic absorption spectrophotometry.** Teruo, A. Translated from *Nippon Dojo Hiryogaku Zasshi;* **46**: No. 10, 421-424(1975). 9p. Dep. NTIS, PC A02/MF A01.

Methods of determining the total beryllium content in soil using atomic absorption spectrophotometry were considered, and a rather satisfactory method was adopted. This method was applied to 14 unpolluted soil samples. The results are outlined below: (1) The method of determining total beryllium content in soils was established as follows: The sodium carbonate fusion method was applied to soil to obtain a sample solution, 50 ml of which (corresponding to 0.5 g of soil) is placed in a 200-ml beaker. While stirring the solution, ammonia water is added to adjust the pH to approximately 1.5. Then EDTA.4Na (10 g) and acetylacetone (0.5 ml) are added, and more ammonia water is added to adjust the pH to 7. The solution is then placed in a 200-ml separating funnel and extracted using 5 ml MIBK. Using a nitrous oxide-acetylene flame, the beryllium content of the extract is determined by atomic absorption spectrophotometry. (2) This determination method is not subject to interference by metal ions contained in the soil. (3) When 1, 2, and 2 μg of beryllium were added to 1 g of soil, which was then treated with the sodium carbonate fusion method, and then measured for beryllium content using this method, virtually 100 percent of the added beryllium was recovered. (4) 14 varieties of topsoil which it was thought could not be polluted by beryllium had an average beryllium content of 1.32 (0.50 to 1.95) ppM. Excluding two types of red earth, all samples fell between 1 and 2 ppM.

57205 **Isotope effects and spectroscopy.** Nash, C.P. (Univ. of California, Davis). pp 29-43 of In Isotopes and chemical principles. Rock, P.A. (ed.). Washington, DC; American Chemical Society (1975).

From 167. national meeting of the American Chemical Society; Los Angeles, California, USA (31 Mar 1974).

See CONF-740349—P6.

One of the most valuable techniques available to any kind of spectroscopist is that of isotopic substitution. This paper will discuss a few applications of the method to problems in the optical spectroscopy of atoms, diatomic and small polyatomic molecules, the vibrations of transition metal complexes, hydrogen bonding, solvation, and optical activity.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 55680, 55884, 56512

57206 (BERC/RI—76/14) **Developing empirical correlations from basic GPC data and deriving of fundamental GPC parameters for a given system.** Hirsch, D.E.; Coleman, H.J.; Dooley, J.E.; Thompson, C.J. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Aug 1977. 73p. Dep. NTIS, PC A04/MF A01.

The Bartlesville Energy Research Center, in cooperation with American Petroleum Institute Research Project 60, used gel permeation chromatography (GPC) in the separation and characterization of the heavy ends of petroleum. The correlations are now being used to characterize oils from other fossil fuel sources such as coal, shale, and tar sands. By the use of retention-volume data for a few compounds, several fundamental parameters were developed and correlated. The parameters involved are expressed in terms of retention volume increments which are additive and allow precise calculation of molecular volumes, densities, and retention volumes of many compounds (without GPC experimentation) based upon retention-volume data on a few compounds. The result is an array of numerical values and groups of selective rules for their combinations. Heteroatomic molecules (N, S, and O analogs of hydrocarbons) could be included. The fundamental GPC parameter correlations can be extended and shown to be of extreme practical importance in characterizing saturate, monoaromatic, diaromatic, and polyaromatic-polar concentrates from 350° to 550°C petroleum distillates. Lower boiling (200° to 350°C) samples also have been analyzed by this method with excellent success.

57207 (EPA—625/1-76-001a) **Process design manual for phosphorus removal.** (Environmental Protection Agency, Washington, D.C. (USA)). Apr 1976. vp. Protection Agency, Washington, DC.

The discharge of phosphorus-containing wastewaters into the surface waters of the United States has contributed to their overfertilization and eutrophication. As a result, efforts are now being made to remove phosphorus from wastewater. This manual discusses phosphorus removal methods that have been found effective and practical for use at treatment plants. All the methods included involve chemical precipitation of the phosphorus and removal of the resultant precipitate. Precipitants include salts of aluminum and iron, and lime. The practical points of addition are before the primary settler, in the aerator of an activated sludge plant, before the final settler, or in a tertiary process. Included in the discussion of each treatment method is a description of the method, pilot or full-scale performance data, equipment requirements, design parameters, and costs. This information should be of value to designers, municipal officials, regulatory agencies, city planners, and treatment plant operators.

INORGANIC AND PHYSICAL CHEMISTRY

57208 **Behavior of flawed pressure vessels.** Saxton, H.J.; Dahlke, L.W.; Jorgenson, W.E.; Keilman, J.C.; Odegard, B.C.; Willis, A.R. (Sandia Labs., Livermore, CA). pp 489-505 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

A study was conducted to determine the extent that well-characterized flaws degrade the performance of spherical pressure vessels and to evaluate the ability of advanced nondestructive test

techniques to detect these flaws. This interdisciplinary study provides a major step towards establishing quantitative relationships between nondestructive acceptance criteria and the actual performance of flawed pressure vessels. When applied during proof testing, holographic techniques were found to detect inner wall defects spanning 10% or more of the wall thickness. Burst performance data and growth data obtained by radiographing under load forms the basis of analytical studies directed at evaluating the performance of tough materials in the presence of flaws. Both elastic-plastic finite element and J-integral techniques have been applied.

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 55574, 55773, 55978, 55996, 55997, 55998, 57229, 57233, 57237, 57350

57209 (BNL—22982) **Neutron diffraction studies of tetrahedral cluster transition metal hydride complexes: $HFeCo_3(CO)_9(P(OCH_3)_3)_3$ and $H_3Ni_4(C_5H_5)_4$.** Koetzle, T.F.; McMullan, R.K.; Bau, R.; Hart, D.W.; Teller, R.G.; Tipton, D.L.; Wilson, R.D. (Brookhaven National Lab., Upton, N.Y. (USA); University of Southern California, Los Angeles (USA). Dept. of Chemistry). 1977. Contract EY-76-C-02-0016. 23p. (CONF-770510—5). Dep. NTIS, PC A02/MF A01.

From American Chemical Society meeting; Montreal, Canada (May 1977).

Structures of the tetrahedral cluster transition metal hydride complexes $HFeCo_3(CO)_9(P(OCH_3)_3)_3$ and $H_3Ni_4(C_5H_5)_4$ have been investigated by low-temperature neutron diffraction techniques. Both complexes have approximate C_s/sub v/ symmetry. In $HFeCo_3(CO)_9(P(OMe)_3)_3$ the hydride ligand is found outside the $FeCo_3$ cluster, 0.978(3) A from the Co_3 face, and essentially on the molecular three-fold axis, triply bridging the cobalt atoms. Mean distances in the cluster are Co-Co 2.489(7), Co-Fe 2.559(2), Co-H 1.734(4) A. In $H_3Ni_4(Cp)_4$ the three hydride ligands are face-bridging, and their mean displacement from the faces of the cluster is 0.90(3) A. The H_3Ni_4 core may be envisaged as a distorted cube, with one vertex unoccupied. Mean distances are Ni-Ni 2.469(6), Ni-H 1.691(8), H...H 2.316(6) A. The observed geometries of the two clusters considered here suggest a plausible model for chemisorption of hydrogen on (111) faces of cubic and (001) faces of hexagonal close-packed metals, in which hydrogen atoms are located approximately 1 A above the centers of triangles of metal atoms.

57210 (CALT—767P8-7) **Application of ion cyclotron resonance spectroscopy, photoionization mass spectrometry and photoelectron spectroscopy to study the properties and reactions of ions in gases. Technical progress report, April 1, 1976—January 31, 1977.** (California Inst. of Tech., Pasadena (USA)). 1977. Contract EY-76-S-03-0767. 41p. Dep. NTIS $4.00.

A summary with citations to published work is presented of studies made on the chemical behavior of ions in gases. Planned extension of the work into energy-related fields is reviewed. (JSR)

57211 (LBL—6221) **Surface crystallography of clean platinum single crystals and adsorbed hydrocarbon overlayers studied by low energy electron diffraction.** Stair, P.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1977. Contract W-7405-ENG-48. 233p. Dep. NTIS, PC A11/MF A01.

Thesis.

The intensities of the low-energy electron diffraction (LEED) beams backscattered from the clean platinum (111) and clean, reconstructed platinum (100) surfaces are measured by a photographic technique. The LEED intensities are also measured for the ordered (2 x 2) hydrocarbon overlayers of acetylene, ethylene, methylacetylene and propylene as well as the ordered benzene overlayers adsorbed on the Pt (111) surface. The intensities are presented in an appendix in the form of normalized diffraction beam intensity versus incident electron energy (I-V curves).

57212 (UCID—17507) **Laboratory experiment demonstrating the way in which a steam barrier prevents the dissolution of salt buried in a flooded packed bed.** Taylor, R.W.; Bowen, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Jul 1977. Contract W-7405-ENG-48. 9p. Dep. NTIS, PC A02/MF A01.

We have conducted a laboratory experiment to demonstrate a way in which a solid material can be prevented from dissolving in water. The differential solubility of salt (NaCl) in steam vs water is exploited. As long as the temperature of the area and water surrounding the salt is maintained above the boiling point of water, the salt cannot dissolve. This phenomenon, known as the thermal barrier, has far-reaching implications for preventing the dispersal of contaminants present near groundwater sources (e.g., created by underground explosions).

57213 **Model for unimolecular reaction of sulfur hexafluoride.** Lyman, J.L. (Los Alamos Scientific Laboratory, University of California, Group AP-3, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **67**: No. 5, 1868-1876(1 Sep 1977).

The thermal dissociation data for SF_6 have been re-evaluated using RRKM unimolecular reaction rate theory and were found to be consistent with a higher value for the sulfur—fluorine bond strength (92 kcal/mole). A model based on a rate equation formalism has been developed that includes unimolecular dissociation, collisional energy transfer (V—T processes), and absorption and emission of laser radiation. The model was designed to test theories of absorption of laser radiation for laser-induced chemical reaction in SF_6 that are amenable to a rate equation formalism. It was found that the thermal reaction and vibrational relaxation data could be adequately reproduced. Sample calculations of laser-induced chemical reactions are performed.

57214 **Standard state entropies of the aqueous rare earth ions.** Spedding, F.H.; Rard, J.A.; Habenschuss, A. (Ames Lab., IA). *J. Phys. Chem.;* **81**: No. 11, 1069-1074(2 Jun 1977).

Recently data have become available for the activity coefficients of 14 rare earth chlorides, and for the heats of dilution of 13 rare earths chlorides, from dilute solution to saturation at 25°C. In addition, new heats of solution data have been reported for the hydrated crystals of 13 of the rare earth chlorides. These data have been used here, together with crystal entropy data, to calculate standard state ionic entropies for the rare earth ions in aqueous solution. The standard state ionic entropies form two series when plotted against the inverse square of the ionic radius of the rare earth ion. The S shape of this series curve was found to be consistent with a decrease in the rare earth ion's inner-sphere hydration number between Nd and Tb, and with an increase in total ionic hydration from La to Lu.

57215 **Mechanisms of chemical oscillators: conceptual bases.** Field, R.J. (Univ. of Montana, Missoula); Noyes, R.M. *Acc. Chem. Res.;* **10**: No. 6, 214-221(Jun 1977).

General aspects of chemical oscillators are discussed using a specific model to illustrate some important concepts concerning the theory of chemical oscillators. Models for both temporal chemical oscillators and spatial chemical oscillators are presented. (BLM)

57216 **Estimate of the intermolecular polarization contribution to the static dielectric constant of water.** Kress, J.W.; Kozak, J.J. (Univ. of Notre Dame, IN). *J. Chem. Phys.;* **64**: No. 4, 1706-1719(15 Feb 1976).

Molecular-structure data derived from recent quantum-chemical studies are used in conjunction with the Mandel—Mazur theory of the static dielectric constant to estimate the importance of intermolecular polarization contributions to the static dielectric constant of water. A scalar expression for the static dielectric constant is identified and then investigated via a multibody decomposition in which the effects of 2-, 3-, ... n-body interactions are displayed and then analyzed numerically. The main conclusion is that the intermolecular polarization contribution is of crucial importance in determining the static dielectric constant of water. Further, the calculations show that the predicted dielectric constant is extraordinarily sensitive to the geometry of the first hydration shell; thus, the use of a slightly inaccurate potential function may lead to a predicted dielectric constant in significant disagreement with the experimental value.

57217 (ORNL-tr—4405) **Mechanism of nitrous acid decomposition.** Kobayashi, H.; Takezawa, N.; Hara, K.; Nikki, T.; Kitano, K. Translated by H. Kubota from *Nippon Kagaku Kaishi;* No. 3, 383-387(1976). 9p. Dep. NTIS, PC A02/MF A01.

The mechanism of nitrous acid decomposition was studied. It was concluded that the reaction $2HNO_2 \rightarrow NO + NO_2 + H_2O$ took place at the gas-liquid interface. The rate of the reaction was found to be determined by the diffusion of nitrous acid from the bulk of solution to the gas-liquid interface when the solution was allowed to stand in a stream of nitrogen. Under the shaking condition, on the other hand, the diffusion process was accelerated so that the rate-determining step was shifted to the reaction at the interface. These conclusions were consistent with the results as to the dependence of the rate upon the concentration of HNO_2, H^+ and neutral salt as well as the values of the activation energy and of the rate constant.

57218 **Electronic configurations and bonding in the early actinide metals.** Hill, H.H.; Kmetko, E.A. (Los Alamos Scientific Lab., NM). pp 17-27 of In Heavy element properties. Miller, W. (ed.). Amsterdam; North-Holland Publishing Co. (1976).

The material presented herein is intended to illucidate for the "lay" chemist, metallurgist, or physicist principles relating chemical and physical properties of the actinide metals to their underlying electronic structures. A description of the electronic wavefunctions in metals that have sufficient "chemical" orientation to yield helpful insight into the nature of metallic bonding and its relationship to covalent bonding is presented. Some points of agreement between the chemically based Engel-Brewer theory of bonding in metals and the energy bond description of the electronic structure are indicated. The possible physical significance of the electronic configuration of an atom in a metal is considered, and updated configurations are

presented for several of the lighter actininde metals which largely vindicate those obtained earlier by completely non-relativistic means. (BLM)

57219 Extreme ultraviolet spectra of highly stripped silicon ions. Griffin, P.M. (Oak Ridge National Lab., TN); Pegg, D.J.; Sellin, I.A.; Jones, K.W.; Pisano, D.J.; Kruse, T.H.; Bashkin, S. pp 321-329 of In Beam-foil spectroscopy. Vol. 1. Sellin, I.A. (ed.). New York; Plenum Publishing Corp. (1976).

Results of studies of foil-spectra in the wavelength range of 107-374A from highly stripped Si ions are reported. Many of the lines identified are associated with $\Delta n = 0$ transitions in Si VI-Si XI of the type 2S^2 2p/sup k/ - 2S^2 2p/sup k+1/ or 2S2p/sup k/ - 2p/sup k+1/. The measured wavelengths for 20 MeV incident Si ions are tabulated along with classifications wherever possible. (BLM)

57220 Reaction mechanisms of organic and inorganic ions in the gas phase. Beauchamp, J.L. (California Inst. of Tech., Pasadena). pp 413-444 of In Interactions between ions and molecules. Ausloos, P. (ed.). New York; Plenum Publishing Corp. (1975).

Observations of experiments regarding general classes of ion-molecule processes are presented, and rules are formulated for predicting relativity based on a knowledge of ion structures and charge distributions, simplified energy surfaces associated with ion-neutral encounters, and ion and neutral thermochemical properties. Attention is mainly focused on the reactions of closed shell systems in which all valence electrons are paired. Reactant ions considered are fragments of dissociative ionization processes or the products of ion-molecule reactions. Experimental studies reported utilize the techniques of ion cyclotron resonance spectroscopy. (BLM)

ISOTOPE EFFECTS

REFER ALSO TO CITATION(S) 57234

57221 Isotopic effects on the electronic properties of H_2O and D_2O in the vacuum uv. Heller, J.M. Jr.; Birkhoff, R.D.; Painter, L.R. (Departments of Physics, The University of Tennessee, Knoxville, Tennessee 37916). *J. Chem. Phys.;* 67: No. 5, 1858-1860(1 Sep 1977).

Optical and dielectric functions of liquid H_2O and D_2O at 25°C were obtained in the 2—9.2 eV region of photon energy. The reflectance was measured for several angles of incidence at a liquid—semicylindrical-window interface. The refractive index n and absorption coefficient k were obtained by a least-squares fit of calculated to experimental reflectance. The principle difference observed was the contraction of the D_2O spectra due to the mass effect of the heavier isotope.

57222 Isotope effects and quantum-mechanical tunneling. Weston, R.E. Jr. (Brookhaven National Lab., Upton, NY). pp 44-63 of In Isotopes and chemical principles. Rock, P.A. (ed.). Washington, DC; American Chemical Society (1975).

From 167. national meeting of the American Chemical Society; Los Angeles, California, USA (31 Mar 1974).

See CONF-740349—P6.

The diagnostic methods that have been used to search for tunneling in chemical reactions are reviewed and evaluated. (JSR)

57223 Corrections to the Born—Oppenheimer approximation in the calculation of iotope effects on equilibrium constants. Wolfsberg, M.; Kleinman, L.I. (Univ. of California, Irvine). pp 64-76 of In Isotopes and chemical principles. Rock, P.A. (ed.). Washington, DC; American Chemical Society (1975).

From 167. national meeting of the American Chemical Society; Los Angeles, California, USA (31 Mar 1974).

See CONF-740349—P6.

Corrections to the Born-Oppenheimer approximation were investigated for a number of diatomic hydrides and deuterides in order to obtain information about electronic isotope effects on the gas phase isotopic exchange reaction. The results of some of these calculations are reported. (JSR)

57224 Isotopes and chemical principles. Rock, P.A. (ed.). Washington, DC; American Chemical Society (1975). 226p. (CONF-740349—P6).

From 167. national meeting of the American Chemical Society; Los Angeles, California, USA (31 Mar 1974).

The nine papers presented reviewed the major developments in the field of isotope effects. Separate abstracts were prepared for the individual papers. (JSR)

57225 Quantum mechanical foundations of isotope chemistry. Bigeleisen, J. (Univ. of Rochester, NY). pp 1-28 of In Isotopes and chemical principles. Rock, P.A. (ed.). Washington, DC; American Chemical Society (1975).

From 167. national meeting of the American Chemical Society; Los Angeles, California, USA (31 Mar 1974).

See CONF-740349—P6.

A brief overview, following the historical development of the field, is presented of the quantum and statistical mechanical foundations of isotope chemistry. (JSR)

57226 Isotope effects and reaction mechanisms. Shiner, V.J. Jr. (Indiana Univ., Bloomington). pp 163-183 of In Isotopes and chemical principles. Rock, P.A. (ed.). Washington, DC; American Chemical Society (1975).

From 167. national meeting of the American Chemical Society; Los Angeles, California, USA (31 Mar 1974).

See CONF-740349—P6.

The general framework for the interpretation of experimental results using primary and secondary isotope effects in the study of reaction mechanisms is outlined. (JSR)

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

57227 Isotope separation processes. Spindel, W. (Yeshiva Univ., New York). pp 77-100 of In Isotopes and chemical principles. Rock, P.A. (ed.). Washington, DC; American Chemical Society (1975).

From 167. national meeting of the American Chemical Society; Los Angeles, California, USA (31 Mar 1974).

See CONF-740349—P6.

In this paper a number of isotope separating processes will be examined, particularly those utilized on a large industrial scale. The processes reviewed include electromagnetic separation, thermal diffusion, U enrichment by gaseous diffusion, and deuterium enrichment by exchange and distillation. Finally, the fundamental principles of a photochemical method of isotope separation based upon excitation by laser light will be outlined.

57228 Electrochemical determination of equilibrium constants for isotope-exchange reactions. Rock, P.A. (Univ. of California, Davis). pp 131-162 of In Isotopes and chemical principles. Rock, P.A. (ed.). Washington, DC; American Chemical Society (1975).

From 167. national meeting of the American Chemical Society; Los Angeles, California, USA (31 Mar 1974).

See CONF-740349—P6.

Experimental results for lithium and hydrogen isotope exchange reactions obtained in a double electrochemical cell and for hydrogen isotope exchange in the gaseous phase are summarized. Work in progress on calcium isotope exchange is described. The results of hydrogen isotope exchange were used as a probe for the study of ion solvation and of lithium isotope exchange for the evaluation of partition function ratios for isotopic solids. The partition function ratios for isotopic solute species were evaluated for the summetric and for the symmetric solvent case. (JSR)

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 55774, 55995, 57211, 57220, 57236

57229 Nuclear magnetic resonance studies of diamagnetic metal—aminopolycarboxylate complexes. Baisden, P.A.; Choppin, G.R.; Garrett, B.B. (Florida State Univ., Tallahassee). *Inorg. Chem.;* 16: No. 6, 1367-1372(Jun 1977).

Proton resonance spectra of EDTA, MEDTA, and HEDTA complexes of diamagnetic ions including alkali, alkaline earth, and rare earth metals are described. Quartet splittings of the methylenic protons of the acetate groups, indicative of long-lived metal—nitrogen bonds, are found for each ligand in the complexes of the cations of higher charge density. The ligand proton chemical shifts are shown to correlate with the effective charge density of the metal ion. Evidence is presented that this correlation is reflective of ordering in the solvation shell rather than a result of direct metal—ligand electrostatic or inductive effects.

57230 Reaction of Type II biradicals with paraquat ions. Measurement of biradical lifetimes. Small, R.D.; Scalano, J.C. (Univ. of Notre Dame, IN). *J. Phys. Chem.;* 81: No. 9, 828-832(5 May 1977).

A laser photolysis study of the Norrish type II reaction of γ-methylvalerophenone in the presence of paraquat ions has allowed us to measure for the first time the lifetime of a type II biradical and the rate constant for the intermolecular reaction with paraquat ions. In methanol at room temperature tau/sub B/ = (97 +- 15) ns and k/sub T/ = (4.6 +- 1.0) x 10^9 M^{-1} s^{-1}. The value of the lifetime is considerably shorter than values estimated previously from competitive studies. A fraction of the paraquat radical ions generated in the trapping step decay via reaction with the radical $PhCOCH_2CH_2CMe_2$.

57231 Study of dimerization in acetonitrile vapor by measurement of thermal conductivity. Renner, T.A.; Blander, M. (Argonne National Lab., IL). *J. Phys. Chem.;* 81: No. 9, 857-861(5 May 1977).

The thermal conductivity of acetonitrile vapor was measured in a modified thick hot-wire cell between 338 and 387 K at pressures ranging from approximately 100 to 1050 Torr (13.3 to 140 kPa). Analysis of the experimental data indicates that a dimeric species is the main source of the observed enhancement of the thermal conductivity of the vapor due to association reactions. Equilibrium constants for the reaction $2CH_3CN$ reversible $(CH_3CN)_2$ were determined from the thermal conductivity data. The enthalpy of formation of the acetonitrile dimer is -5002 cal/mole (-20.93 kJ/mole) and the entropy of formation is -21.15 cal/mole K (-88.49 J/mole K).

57232 Use of ^{13}C and ^{1}H nuclear magnetic resonance to probe internal motion in dimethyl sulfoxide. London, R.E. (Los Alamos Scientific Lab., NM); Eastman, M.P.; Matwlyoff, N.A. *J. Phys. Chem.;* **81**: No. 9, 884-887(5 May 1977).

^{13}C NMR and ^{1}H NMR have been used to study the internal rotation of the methyl groups of Me_2SO in Me_2SO—H_2O mixtures. The sensitivity of various NMR methods for studying internal rotation is discussed and it is found that measurements which are proportional to the internal rotation parameter chi/sup CH/ are optimal if the rate of internal rotation is 1 to 10 times that of overall molecular rotation. Alternatively, the ratio T_1/sup ^{1}H//T_1/sup ^{13}C/, which is proportional to the ratio of the parameters chi/sup CH// chi/sup HH/, is most sensitive to the effect of internal motion for rates in the range 10 to 100 times the rate of overall molecular motion. The latter method is found to be fairly sensitive for the case of internal methyl rotation with the ratio changing by more than a factor of 2 in going from the no rotation to the very fast rotation case. In using this approach, care must be taken in evaluating only the intramolecular contribution to T_1/sup ^{1}H/. This has been accomplished in the present case by the use of ternary D_2O—Me_2SO-d_6—Me_2SO mixtures. The results of these studies indicate that the rate of internal methyl rotation is slow compared with the rate of overall molecular rotation.

57233 Novel co-ordination of sulphur dioxide. The crystal and molecular structure of nitrosyl(sulfur dioxide)bis(triphenylphosphine)rhodium. Moody, D.C.; Ryan, R.R. (Los Alamos Scientific Lab., NM). *J. Chem. Soc. (London), Chem. Commun.;* 503-504(1976).

Crystals of $[Rh(NO)(SO_2)(PPh_3)_2]$ have been obtained from SO_2-saturated solutions of $Rh(NO)(PPh_3)_2$ in benzene-heptane mixtures; the x-ray crystal structure shows the SO_2 ligand co-ordinated to the rhodium through the sulphur atom and through one of the oxygen atoms, while the RhNO angle is 140°.

ISOTOPE EFFECTS

REFER ALSO TO CITATION(S) 57226

57234 Condensed phase isotope effects, especially vapor pressure isotope effects: aqueous solutions. Van Hook, W.A. (Univ. of Tennessee, Knoxville). pp 101-130 of In Isotopes and chemical principles. Rock, P.A. (ed.). Washington, DC; American Chemical Society (1975).

From 167. national meeting of the American Chemical Society; Los Angeles, California, USA (31 Mar 1974).

See CONF-740349—P6.

The theory of isotope effects in condensed phase systems, especially vapor pressure isotope effects (VPIE) is briefly reviewed. It is pointed out that the VPIE can be employed as one measure of the effect of intermolecular forces on the motions of molecules in condensed phases. This is illustrated with a number of examples from the recent literature and from our own laboratory. A more detailed description of our recent work on thermodynamic solvent isotope effects in aqueous systems is presented. Experiments on vapor pressures, freezing points, and heats of solution and dilution of solutions of electrolytes in HOH and DOD are described. Implications are discussed with respect to the aqueous solvent structure problem.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 57224

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 57171

57235 Mechanism of the disproportionation of superoxide radicals. Bielski, B.H.J.; Allen, A.O. (Brookhaven National Lab., Upton, NY). *J. Phys. Chem.;* **81**: No. 11, 1048-1050(2 Jun 1977).

New measurements are reported on the rate of the spontaneous uncatalyzed second-order decay of the superoxide radical in aqueous solution at 23°C. By extreme purification of reagents, and addition of small amounts of EDTA to sequester traces of catalytic metal ions, purely second-order kinetics were found up to pH 13.2. The pH effects clearly show that the ionic form O_2^- never reacts with itself but only with the HO_2 in equilibrium with it, even when the ratio HO_2/O_2^- is as small as 2×10^{-4}; the rate constant for $O_2^- + O_2^-$ is less than 0.3 $M^{-1} s^{-1}$. The pK of HO_2 was determined as 4.75 +- 0.08, and the bimolecular rate constants were $k_1 = (7.61 \pm 0.55) \times 10^5 M^{-1} s^{-1}$ for $HO_2 + HO_2$ and $k_2 = (8.86 \pm 0.43) \times 10^7 M^{-1} s^{-1}$ for $HO_2 + O_2^-$, all in good agreement with published values. The change in the spontaneous decay of superoxide radicals with pH follows the equation k/sub obsd/ = [k_1 + k_2K/sub HO_2//(H^+)]/[1 + K/sub HO_2//(H^+)]^2. The optical extinction coefficients of hydrogen peroxide were determined over the pH range 6.1 to 13.8 at wavelengths from 280 to 230 nm.

57236 Radiation-induced homolytic aromatic substitution. VI. The effect of metal ions on the hydroxylation of benzonitrile, anisole, and fluorobenzene. Eberhardt, M.K. (Puerto Rico Nuclear Center, San Juan). *J. Phys. Chem.;* **81**: No. 11, 1051-1057(2 Jun 1977).

The radiation-induced hydroxylation of benzonitrile, anisole, and fluorobenzene has been investigated. In absence of oxidizing agents (O_2, metal salts) only trace amounts of substituted phenols are formed. Some metal salts ($Fe(CN)_6^{3-}$, Fe^{3+}, $Cr_2O_7^{2-}$) oxidize the intermediate hydroxycyclohexadienyl radicals and give a very high conversion of OH radicals to phenols, whose isomer distribution is dependent on the metal salts. With Cu^{2+} salts ($Cu(ClO_4)_2$, $CuSO_4$, $CuCl_2$) no oxidation of the hydroxycyanocyclohexadienyl radicals was observed. Oxidation with $K_3Fe(CN)_6$ leads in a quantitative way to the corresponding phenols. It was shown that in the hydroxylation of anisole, fluorobenzene, bromobenzene, toluene, benzonitrile, and nitrobenzene a linear relationship exists between log 2k/sub m// 2k_0 + 2k/sub m/ + k/sub p/ and log k/sub p//k/sub m/ and σ/sub M/ values. Electron-withdrawing substituents give a high percentage of meta hydroxylation, whereas electron-donating substituents give a low percentage of meta hydroxylation. As the difference in electron density between ortho and meta position increases the electrophilic OH radicals attack preferentially at the ortho and para positions. It was concluded that dehydration from the initially formed hydroxycyclohexadienyl radicals takes place only if the substituent is electron donating (+M effect), but not if the substituent is electron withdrawing (NO_2, CN).

57237 Ultraviolet part of transient absorption spectrum induced in liquid ammonia by nanosecond pulse radiolysis. Farhataziz. (Univ. of Notre Dame, IN). *J. Phys. Chem.;* **81**: No. 9, 827-828(5 May 1977).

The absorption spectra induced in neat liquid ammonia and ammoniacal solution of N_2O by nanosecond pulse radiolysis have been measured for wavelength range 250 to 325 nm. The results indicate that the absorption spectrum induced in liquid ammonia is a composite of absorption spectra of e/sub am/$^-$ and NH_2. The absorptions due to e/sub am/$^-$ decrease with decreasing wavelength, and are attributed to the tail of the absorption spectrum (maximum absorption in near infrared) of e/sub am/$^-$. The absorption spectrum for NH_2 has a shoulder at approximately 255 nm. In liquid ammonia at 23°C, the extinction coefficient for NH_2 at 250 nm is $1.1 \times 10^3 M^{-1} cm^{-1}$.

57238 Comparison of photoconductivity and optical spectra of the trapped electron in polar aqueous and alcoholic glasses. Rice, S.A.; Kevan, L. (Wayne State Univ., Detroit). *J. Phys. Chem.;* **81**: No. 9, 847-850(5 May 1977).

The photoconductivity spectra of polar aqueous and alcoholic matrices at 85 K containing trapped electrons are reported and are of two principal types. Type A systems (aqueous 10 M NaOH, 7 M $NaClO_4$, and 7.5 M CH_3COOK) show a similar wavelength dependence between the photoconductivity and optical absorption spectra, which implies dominance of bound-continuum transitions. Type B systems (aqueous 2.35 M sucrose, aqueous 10 M LiCl, methanol, equivolume ethylene glycol—water, glycerol, and possibly aqueous 7.2 M sodium formate) display photoconductivity spectra of the trapped electron which are significantly blue shifted from the optical absorption spectra, indicating dominance of bound—bound transitions in the main part of the optical spectra and a bound—continuum contribution in the high energy tail of the optical spectra. Also trapped electrons in aqueous 5 M K_2CO_3 show some correspondence of the photoconductivity and optical spectra at long wavelengths while at short wavelengths the photoconductivity spectra are blue shifted. Thus, both bound—bound and bound—continuum transitions may exist, but closely overlap. For aqueous 10 M NaOH glasses no photocurrent emitted into vacuum could be observed above the noise level which was approximately 10^{-3} of the photocurrent.

57239 Reaction of e/sub aq/$^-$ + H_3O^+. Concentration effects of acid or salts. Jonah, C.D.; Miller, J.R.; Matheson, M.S. (Argonne National Lab., IL). *J. Phys. Chem.;* **81**: No. 9, 931-934(5 May 1977).

The rate constant, k(e/sub aq/$^-$ + H_3O^+), has been measured in dilute $HClO_4$, alone and with $LiClO_4$ added up to 2.5 M, and in concentrated $HClO_4$, alone and with $LiClO_4$ or $NaClO_4$ added up to 2.5 M. The rate constant has the same dependence upon total concentration either for $HClO_4$ alone or for $HClO_4$ + $LiClO_4$. The

results show that changes in k(e/sub aq/$^-$ + H_3O^+) are determined by changes in the diffusion-controlled encounter rate and by changes in the activities of e/sub aq/$^-$ and H_3O^+. Any time-dependent effect in the rate constant is not more than 10 percent for hydrated electrons with lifetimes longer than 30 ps.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

HOT-ATOM CHEMISTRY

57240 Gas to liquid to solid transition in halogen hot atom chemistry. IV. The suggestion of multiple enhancement reactions in high energy iodine-128—ethane systems. Berg, M.E.; Loventhal, A.; Adelman, D.J.; Grauer, W.M.; Rack, E.P. (Univ. of Nebraska, Lincoln). *J. Phys. Chem.;* **81**: No. 9, 837-842(5 May 1977).

The gas to condensed phase transition technique has been used to study the iodine-128—ethane system. Total organic product yields were found to range from 1.1 (1 atm gas) to 61.2 percent (-23°C liquid). Various molecular and enhancement reactions are evaluated using available data and a comparison is made among ethane and other two carbon hydrocarbons.

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 56196, 57210

57241 (LA—6681-MS) **Reaction between plutonium and deuterium. Part II. Rate measurements by weight changes.** Bowersox, D.F. (Los Alamos Scientific Lab., N.Mex. (USA)). Jul 1977. Contract W-7405-ENG-36. 7p. Dep. NTIS, PC A02/MF A01.

The effects of pressure and temperature upon the rate and mechanism of the reaction between plutonium and deuterium have been studied for temperatures to 400°C at pressures from 1 to 15 kPa. The rate was determined by measuring the weight changes of plutonium disks as the reaction proceeded. Below 200°C the reaction product spalled to expose fresh metal. The equation R = k/sub T/AP$^{0.6}$ fits the data, where the rate R is the milliequivalents of deuterium reacting per hour, A is the geometrical surface area, P is the deuterium pressure, and k/sub T/ is the velocity constant at temperature T. The energy of activation for the spalling reaction is 5.9 kcal . mol^{-1} for $PuD_{2.7}$. Between 250 and 400°C the product adhered to the parent metal to form a growing layer. The equation R = k/sub T/*AP/ΔW fits the rate data, where R, A, and P are defined above, ΔW is the measured weight change in milliequivalents of deuterium, and k/sub T/* is the velocity constant at temperature T.

57242 (Y—2078) **Uranium/water vapor reactions in gaseous atmospheres.** Jackson, R.L.; Condon, J.B.; Steckel, L.M. (Oak Ridge Y-12 Plant, Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

Experiments have been performed to determine the effect of varying humidities, gaseous atmospheres, and temperatures on the uranium/water vapor reaction. A balance, which allowed continuous in-system weighings, was used to determine the rates of the uranium/water vapor reactions at water vapor pressures of 383, 1586, and 2853 Pa and at temperatures of 80, 100, and 150°C in atmospheres of hydrogen, argon, or argon/oxygen mixtures. Based on rate data, the reactions were characterized as hydriding or nonhydriding. Hydriding reactions were found to be preferred in moist hydrogen systems at the higher temperatures and the lower humidities. The presence of hydrogen in hydriding systems was found to initially inhibit the reaction, but causes an acceleration of the rate in the final stages. In general, reaction rates of hydriding systems approached the hydriding rates calculated and observed in dry hydrogen. Hydriding and nonhydriding reaction rates showed a positive correlation to temperature and water vapor pressure. Final reaction rates in moist argon/oxygen mixtures of 1.93, 4.57, and 9.08 mole percent oxygen were greater than the rates observed in moist hydrogen or argon. Final reaction rates were negatively correlated to the oxygen concentration.

RADIOISOTOPE PRODUCTION

57243 (BNL—22993) **^{122}Xe—^{122}I generator: a preliminary report.** Richards, P.; Ku, T. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 13p. (CONF-770673—2). Dep. NTIS, PC A02/MF A01.

From 24. annual meeting of the Society of Nuclear Medicine; Chicago, Illinois, USA (23 Jun 1977).

A generator system is developed to produce the ultrashort-lived positron-emitter iodine-122 (3.62 m) from its parent xenon-122 (20.1 h). The parent xenon-122 can be produced as a by-product in the production of xenon-123 from proton irradiation of sodium iodide target. The generator consists of a xenon reservoir chamber and an ingrowth or milking chamber. The sequence of operation involves transferring xenon using liquid nitrogen from the reservoir to the milking vessel, allowing fresh iodine-122 to grow in for a few minutes, transferring the xenon back to the storage reservoir, and then rapidly rinsing the iodine out of the milking vessel. The radionuclidic purity of the carrier-free iodine-122 is high, containing less than 0.1 percent radioxenons and other radioiodines. The potential applications of iodine-122 include cardiac and large vessel angiography and studying heart dynamics. It is also well suited for use in positron-emission tomography.

COMBUSTION CHEMISTRY

REFER ALSO TO CITATION(S) 55804, 55976, 55977, 55980, 57318

57244 Production of nitrogen compounds from molecular nitrogen in fuel-rich hydrocarbon-air flames. Haynes, B.S. (Univ of NSW, Kensington, Aust). *Fuel;* **56**: No. 2, 199-203(Apr 1977).

Measurements of HCN, NH_3 and NO concentrations in the burnt gases of a number of fuel-rich hydrocarbon-air flames have been made. Only HCN and/or NO leave the primary reaction zone of all flames studied, while NH_3 is formed later in the burnt gases. The behavior of these species in the post-flame zone is qualitatively similar to that observed in flames seeded with fuel-nitrogen. The generation of nitrogen compounds from molecular nitrogen is obviously due not only to the Zeldovich mechanism but also to some as yet unidentified hydrocarbon–N_2 reaction. 14 refs.

57245 Numerical evaluation of thermodynamic equilibrium states for gas mixtures. Cardella, C. (Univ di Roma, Italy). *Termotecnica (Milan);* **30**: No. 12, 651-661(Dec 1976). (In Italian).

The general form of the problem of the evaluation of thermodynamic equilibrium states and concentrations of the chemical species that make up a given gas mixture is solved in adiabatic, non-isoentropic conditions (i.e. in presence of dissociative phenomena) over a wide range of temperatures and of specific volumes. The solution of the resulting set of equations in obtained considering simultaneously all the equations involved. A particularly flexible algorithm has been used. The computational method is, in fact, independent from the number of variables and from their mutual relationships, and is therefore particularly suitable to sovle complex systems of equations.

57246 Linearized nonequilibrium flow of a combustible mixture during interaction of two supersonic gas streams. Gilinskii, M.M. *Fluid Dyn. (USSR) (Engl. Transl.);* **11**: No. 3, 479-482(1976).

Considered is supersonic stream of a premixed combustible mixture of gases which meet a gas stream at a certain angle θ. Such a situation can occur during the artificial tangential blowing of a jet through the side surface of a flying vehicle, during distributed supersonic blowing of a combustible mixture at a small angle to a surface, during combustion behind the rear shock on the trailing edge of a thin profile, etc. Combustion behind a shock wave is described using a formula for an irreversible exothermal reaction. A flow perturbed because of heat evolution is sought in a linearized formulation by assuming that it differs slightly from the unperturbed flow corresponding to the interaction between two supersonic adiabatic streams.

57247 Computational simulation of shock-induced gas-phase reactions. Noetzold, D.; Reidelbach, H.; Algermissen, J. (Univ Stuttgart, Ger). *Forsch. Ingenieurwes.;* **42**: No. 2, 41-46(1976). (In German).

A computer program coded in FORTRAN has been developed for computational simulation of shock-induced gas-phase reactions with the effects of heat, mass and radiative transfer neglected. The flow behind the quasi-stationary wave is described by a one-dimensional model, which is a good approximation of the actual situation found in shock-tube investigations. The main characteristics of the computer program are efficiency in storage requirements, computational ease, automatic control of integration steps, and relatively short run times. Two numerical examples are presented to demonstrate the applicability of the computer program: the combustion of hydrogen in air (run time on CDC 6600 only 29 s) and the induction period of ethane oxidation. Run times are shown to be strongly dependent on the number of gas components, but only weakly dependent on the number of chemical reaction steps. 10 refs.

57248 Flame suppression on cylindrical fuel rods. Little, M.W. Providence; Brown Univ. (1976). 143p. Microfilms Order No. 77-14,158.

Thesis (Ph. D.).

This work presents experimental and analytical results providing insight into the propagation/extinction process for solid fuel fires. Propagation velocity was found to be a linear function of oxygen mass fraction for oxygen concentrations equal to and less than the atmospheric value. Suppression of the flame by nitrogen and CF_3Br was studied; CF_3Br was found to be more effective than

nitrogen when compared on a mass basis. Flame velocity was reduced significantly by substituting CF_3Br for nitrogen at constant oxygen mass fraction. Calculations based on measurements of the pyrolyzed fuel surface yielded approximately constant surface regression rate over the range of oxygen concentrations studied. Analysis of the pyrolyzing region yielded a roughly constant heat transfer coefficient over the same range. Temperature measurements were made on the surface and within the fuel samples. An energy balance was constructed using these measurements to evaluate conduction heat transfer and enthalpy of the fuel ahead of the flame. It was found that at extinction (the least attainable burning velocity) there is a small loss of heat from the unburned surface; a previous investigation determined that at atmospheric conditions, the surface received substantial heat from the flame. Estimates were made of the convective and radiative heat transfer from the surface ahead of the flame at the extinction condition. An analysis of conduction in the fuel was presented and utilized to illustrate the approach to extinction as surface heat inputs change. The measured surface heat values at extinction and at atmospheric conditions were also used as inputs; the predicted extinction velocity was quite close to the results of the experiments.

ENGINEERING

GENERAL ENGINEERING

REFER ALSO TO CITATION(S) 56618

57249 (LA—6809) **Empirical model to compute the velocity histories of flyers driven by electrically exploding foils.** Schmidt, S.C.; Seitz, W.L.; Wackerle, J. (Los Alamos Scientific Lab., N.Mex. (USA)). Jul 1977. Contract W-7405-ENG-36. 14p. Dep. NTIS, PC A02/MF A01.

A modification of the gas gun (Gurney) formulation is used to compute the velocity and position histories of flyers driven by electrically exploded metal foils. The model is based on a numerical time integration of an energy conservation statement for the flyer and the expanding high-pressure metal vapor. Empirically altered, experimental power curves are used for the time-dependent energy term in the conservation equation. Computed burst times and flyer velocity histories for 1.5- to 25-mm-square aluminum foils agree favorably with available experimental data. Comparison of calculated and measured results for single cases with exploding copper and magnesium foils suggests that the model is also applicable for these materials.

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 56281, 56282, 57808

57250 (CONF-770634—1) **Versatile multiple outlet semi-ball and socket valve.** Doody, T.J. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 10p. Dep. NTIS, PC A02/MF A01.

From 22. American Scientific Glassblowers symposium; Boston, Massachusetts, United States of America (USA) (19 Jun 1977).

The multiple outlet semi-ball and socket valve was initially designed at the request of bacteriologists who needed a device that could deliver germ-free medium from a large reservoir into a number of growth chambers and could, at the same time, maintain sterile conditions. The valve designed to meet these specifications has unusual versatility for a number of applications.

57251 (COO—3077-140) **Numerical calculation of the transonic flow past a swept wing.** Jameson, A.; Caughey, D.A. (New York Univ., N.Y. (USA). Courant Inst. of Mathematical Sciences). Jun 1977. Contract EY-76-C-02-3077. 97p. Dep. NTIS, PC A05/MF A01.

A numerical method is presented for analyzing the transonic potential flow past a lifting, swept wing. A finite-difference approximation to the full potential equation is solved in a coordinate system which is nearly conformally mapped from the physical space in planes parallel to the symmetry plane, and reduces the wing surface to a portion of one boundary of the computational grid. A coordinate invariant, rotated difference scheme is used, and the difference equations are solved by relaxation. The method is capable of treating wings of arbitrary planform and dihedral, although approximations in treating the tips and vortex sheet make its accuracy suspect for wings of small aspect ratio. Comparisons of calculated results with experimental data are shown for examples of both conventional and supercritical transport wings. Agreement is quite good for both types, but it was found necessary to account for the displacement effect of the boundary layer for the supercritical wing, presumably because of its greater sensitivity to changes in effective geometry.

57252 (UCRL—78367) **Lifetimes of fiber composites under sustained tensile loading.** Chiao, T.T.; Chiao, C.C.; Sherry, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Nov 1976. Contract W-7405-ENG-48. 14p. (CONF-770309—2). Dep. NTIS, PC A02/MF A01.

From Conference on fracture mechanics and technology; Hong Kong, China (21 Mar 1977).

The objectives of the paper are to (1) introduce the test techniques, (2) summarize lifetime data on several composite materials, (3) report preliminary results of an accelerated test method for predicting the life of simple composites, and (4) describe related work in progress on pressure vessels and other filament-wound structures.

57253 (UCRL—78886) **High pressure apparatus for hydrogen isotopes to pressures of 345 MPa (50,000 psi) and temperatures of 1200°C.** Lakner, J.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Jun 1977. Contract W-7405-ENG-48. 17p. (CONF-770706—4). Dep. NTIS, PC A02/MF A01.

From 6. AIRAPT international high-pressure conference; Boulder, Colorado, United States of America (USA) (25 Jul 1977).

A functional new high pressure, high temperature apparatus for hydrogen isotopes uses an internally heated pressure vessel within a larger pressure vessel. The pressure capability is 345 MPa (50 K psi) at 1200°C. The gas pressure inside the internal vessel is balanced with gas pressure in the external vessel. The internal vessel is attached to a closure and is also the sample container. Our design allows thin-walled internal vessel construction and keeps the sample from "seeing" the furnace or other extraneous environment. The sample container together with the closure can easily be removed and loaded under argon using standard glove-box procedures. The small volume of the inner vessel permits small volumes of gas to be used, thus increasing the sensitivity during pressure-volume-temperature (PVT) work.

57254 (Y/DA—7177) **Part stability and fixturing techniques for precision machining.** Woodall, N.D. (Oak Ridge Y-12 Plant, Tenn. (USA)). May 1977. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

When the general area of precision machining is considered, often a different emphasis and a peculiar set of problems are encountered as compared with more conventional metalworking processes. Material-removal rates and production times may be less important as part quality becomes the overriding consideration. The effect of every step in the manufacturing process must be evaluated in order to meet the desired objective. It is not the purpose of this paper to explore all these aspects but, rather, to concentrate on some techniques to improve part stability during precision machining. With the right equipment, it may be possible to machine a part of high dimensional quality only to find that it distorts and no longer meets the specifications after it is released from its machining fixture. The general problem area of uneven stresses in finished parts may be due to several factors: (1) residual stresses may remain in the metal due to prior operations such as rolling or forming; (2) stresses are introduced into the surface of the metal by the material-removal process itself; and (3) the machining fixture may distort the part during machining and thereby cause changes to occur upon release. Some of these factors are considered and methods to minimize these part distortions are presented.

57255 **Mathematical model for cross-flow-induced vibrations of tube rows.** Chen, S.S. (Argonne National Lab., IL). pp 415-426 of In Pressure vessel technology. I. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P1.

A mathematical model is presented for cross-flow-induced vibrations of tube banks including the effects of vortex shedding, fluidelastic coupling, drag force, fluid inertia coupling, and others. The model can predict the details of complex tube-fluid interactions: (1) natural frequencies and mode shapes of coupled vibrations; (2) critical flow velocities; (3) responses to vortex shedding, drag force, and other types of excitations; and (4) the dominant excitation mechanism at a given flow velocity. The analytical results are in good agreement with the published experimental results.

57256 **Stress intensities in flawed pressure vessels.** Smith, C.W.; Jolles, M.; Peters, W.H. (Virginia Polytechnic Inst. and State Univ., Blacksburg). pp 535-543 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

A technique for determining the stess intensity factor (SIF) near pressure vessel flaws or cracks experimentally from photoelas-

tic data for use in two-dimensional problems was developed in the 1950's. This technique was modified and extended to a variety of two-dimensional problems. The technique has been refined further and what has evolved may be regarded as a hybrid technique which affects a marriage between "frozen stress" photoelastic results and a simple least-squares digital computer program for estimating SIF values in three-dimensional problems. This technique, in its original modified form, has been shown to be applicable to a study of surface flaws and the applicability of the method to complex crack body geometries of current technological importance are discussed. The analytical foundations of the method are reviewed.

57257 Analysis and prediction of failure in tubes. Adams, N.J.I. (Nuclear Installations Inspectorate, London). pp 685-694 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

A two parameter fracture criterion, developed for flat plates, and subsequently extended to shells containing through thickness cracks has been defined for application to partial penetration defects in cylindrical shells. In addition, the influence of temperature range and chemically induced variation in fracture response has been examined. The method is found to be applicable, although the introduction of more test variables has led to an increase in scatter of the predicted failure stresses when compared with experimental values.

57258 Studies on the fatigue of branched connections related to the shakedown pressure. Cook, T.R. (Central Electricity Generating Board, Berkeley, Eng.). pp 749-756 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

The concept of shakedown is that regions which plastically deform during initial loading subsequently adopt an elastic mode of deformation. High strain fatigue, i.e. up to 10,000 cycles, will be eliminated. Two branches of different thickness were welded to a common cylindrical vessel and hydraulically tested, simultaneously. The test pressure was the shakedown limit for the stronger branch and about 1.5 x shakedown for the weaker branch. The thinner branch failed by penetration through the weld near the crotch corner at 3,543 cycles. The thicker branch was given 10,000 cycles when, since no cracks were apparent, a starter notch was made in the crotch corner. Leakage occurred after another 10,678 cycles. This crack was also influenced by weld defects. Using fracture mechanics and a reported relationship between crack rate and stress intensity factors, some predictions of endurance at design pressure are derived for these branches. These lives are compared with the British Standard 1515 formula for fatigue avoidance and with the curves given in Section III of the ASME Boiler and Pressure Vessel Code. The former is considered conservative, while the ASME Code curve requires an additional safety factor as suggested by Jettam; A multiplication factor of 2 on the nominal stress concentration factor for welds is then considered satisfactory. It is tentatively considered that such junctions manufactured to Class 1 standard are satisfactory for daily cycling for 30 years, but are marginal for twice daily cycling for that time. This conclusion is tentative, since it depends critically on the size of weld defects present.

57259 Fatigue strength of electron beam welded stainless steel pipes. Tunenari, T.; Shimizu, S.; Ikemoto, Y.; Kobatake, K. (Kawasaki Heavy Industries, Ltd., Japan). pp 757-764 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

The fatigue strength of some SUS316 stainless steel pipes welded by electron beam welding, such as underlip weld, smoothed underlip weld and uranami weld is described. Plate specimens of these welds were tested at room temperature and 773°K under two different principal stress directions which were perpendicular and parallel to the weld line, respectively. Pipe specimens of underlip welds were tested under cyclic internal pressure at room temperature. The strength of various EB welds were compared, and the fatigue strength reduction factors of pipe welds were obtained. The relationships between the fatigue strength reduction factors obtained from plate tests and that obtained from pipe test were also discussed.

57260 Fatigue and fracture behaviour of cracks at nozzle corners: comparison of theoretical predictions with experimental data. Broekhoven, M.J.G. (Delft Univ. of Tech., Netherlands). pp 839-852 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

Two associated problems are discussed which are pertinent to corner cracks at inside transitions of pipe-to-vessel junctions, viz. computation of accurate local K-factors and applicability of such factors to predict fatigue growth and fracture. Results of fatigue crack growth and subsequent fracture experiments are discussed and compared with predictions based on K-factors from a 3-D finite element analysis. The discrepancy in local K values along the crack front found between computational and experimental (fatigue crack growth) results is pointed out and possible causes for its occurrence are discussed. Crack front averaged computed K-values appear to be suitable for predicting average growth behavior. Fracture predictions based on computed local maximum K-values are unconservative but considerably better that if based on averaged computed values.

57261 Creep properties of electric resistance welded boiler tubes under internal pressure. Shikoh, S.; Nohgata, H.; Gondoh, H. (Nippon Steel Corp., Kimitsu, Japan). pp 887-892 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

Creep rupture tests on electric resistance welded (ERW) tubular specimens of carbon steel and 1% Cr-0.5% Mo steel and burst tests on thickness-deviated tubular specimens of carbon steel are described. Also, changes of structures and mechanical properties of 1% Cr-0.5% Mo steel tubes after exposure to 550°C for up to 10,000 hours under a tensile hoop stress of 108 MPa are described. The creep rupture properties of ERW boiler tubes were proved to be quite comparable to those of seamless tubes, and the slightest deviation in wall thickness was shown to affect the internal pressure rupture behavior. Changes of structures at welded portion of ERW 1% Cr-0.5% Mo steel tubes were as same as those of base metal.

57262 Transient and residual stresses from multipass weld in very thick plates and their reduction from stress relief annealing. Ueda, Y. (Osaka Univ.); Fukuda, F.; Nakacho, K.; Takahashi, E.; Sakamoto, K. pp 925-933 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

An investigation into residual stresses induced in a connection of a pressure vessel by multipass welding and their reduction by stress relief annealing was conducted. The study was performed theoretically and experimentally on idealized research models. In the theoretical analyses, the thermal elastic-plastic creep theory developed by the authors was applied and the results of the analysis show a good, fundamental coincidence with the experimental findings. Based on these results, the following items are discussed: the correlation between the welding residual stresses and delayed cracking; transient stresses and intermediate annealing; and conditions of annealing and reduction of the residual stresses.

57263 Material manufacturing and fabrication of ultra-large size hydrodesulphurization reactors. Nakajo, Y.; Yamashita, I.; Mima, S. (Japan Steel Works, Ltd., Hokkaido). pp 1011-1017 of In Pressure vessel technology. II. New York; American Society of Mechanical Engineers (1977).

From 3. international conference on pressure vessel technology; Tokyo, Japan (19 Apr 1977).

See CONF-770414—P2.

Among several pressure vessels working in the petroleum refinery, special attention is paid to the hydrodesulphurization and hydrocracking reactors which are operated under high pressure and high temperature hydrogen-rich environment. The fabrication features of those reactors are described according to the production sequence, starting from design, material manufacturing, welding, postweld heat treatment, and nondestructive examination up to hydrostatic testing and shipping.

57264 Investigation of heat exchange when liquids are boiled in closed two-phase thermosiphons. Bezrodnyi, M.K.; Alekseenko, D.V. (Kiev Polytech Inst, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* 96-101([nd]). (In Russian).

Results are presented of an experimental investigation of heat exchange when liquids are boiled in closed two phase thermosiphons depending on their geometric dimensions, type of the working fluid, pressure in the inner cavity and extent to which it is filled with an intermediate heat carrier. Experiments carried out with water, ethanol, methanol, freon-11, freon-113, and freon-12 are described. As a result of the investigation, specific characteristics of heat exchange when liquids are boiled in heat pipes, compared with the appropriate data for large-volume conditions, are revealed.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 56360, 57731, 57734, 57735

57265 (AD-D—003515) **Fusible heat sink for a cryogenic refrigerator.** Kroebig, H.L. (Department of the Air Force, Washington, D.C. (USA)). 12 Jan 1977. 9p. NTIS PC A02/MF A01.

A fusible heat sink for a cryogenic refrigerator used to provide cooling for a detector in the guidance system of a missile is described. The cryogenic refrigerator has a cold cylinder in contact with the detector and a hot cylinder. The hot cylinder and cold cylinder are connected to a crankcase housing. A heat pipe is connected between the crankcase and the missile skin for providing primary cooling for the crankcase housing. The fusible heat sink is connected to the crankcase with the crankcase forming part of the wall of the heat sink housing. A fusible material is located within the housing. The inside surface of the heat sink housing is coated with nickel and silver to increase the heat transfer between the crankcase and the heat sink.

57266 Natural fluctuations of the tunnel current in Josephson junctions. Landa, P.S.; Tarankova, N.D. (M. V. Lomonosov Moscow State University). *Sov. J. Low Temp. Phys. (Engl. Transl.);* 3: No. 1, 15-21(Jan 1977).

The natural fluctuations of the tunnel current in Josephson junctions due to scattering of quasiparticle excitations by phonons in superconductors which form such a junction are analyzed. The spectra of natural fluctuations of the quasiparticle current, of the critical current, and of the Josephson-current frequency are calculated. An expression is derived for the natural width of the Josephson-current line, which is then evaluated and compared with the experiment.

57267 Josephson effect in tunnel junctions with vanadium and vanadium oxide. Yanson, I.K.; Rybal'chenko, L.F. (Physicotechnical Institute of Low Temperatures, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* 3: No. 1, 21-27(Jan 1977).

A study was made concerning the characteristics of the Josephson effect in V—V/sub x/O/sub y/—Pb tunnel junctions. The results reveal that the critical current I/sub c/ in zero field is anomalously low and corresponds to the conductivity of an S_1—I—S_2 channel in parallel with an N—I—S_2 channel. The dependence of the critical current on the magnetic field intensity signifies a barrier layer which is very homogeneous in the junction plane. The anomalous I/sub c/(T) characteristic as well as the temperature dependence of the period of I/sub c/(H) oscillations suggests that the value of the order parameter in vanadium films near the barrier depends on the coordinates here. A comparison with the characteristics of V—Al—Al/sub x/O/sub y/—Pb junctions (with d/sub Al/ ~100 A) indicates that the presence of vanadium oxide lowers the value of the superconducting order parameter in the vanadium film. The intrinsic step shape of the current—voltage characteristics is analyzed here and the corresponding parameters are used for independently determining the depth to which the magnetic film penetrates the vanadium film.

57268 Method of study for cryogenerators in variable operating conditions. physical environment of the field magnet in operation. Sabrie, J.L. (Electr de Fr). *Rev. Gen. Electr.;* 85: No. 12, 957-970(Dec 1976). (In French).

The transition risk of superconductors requires, for cryogenerators, a fine predetermination of the physical parameters of the operating conditions of the field magnet in service if it is desired to estimate some of the technical and economical characteristics affecting the design and the operation of an electric system. Transition of the field magnet involving a temporary nonavailability, cannot be admitted except in case of a material damage, and the risk of transition must be studied and limited in all possible operating conditions. For this purpose, a method for calculating the transient changes of the fields, current and losses of the fields, current and losses at the rotor level has been developed at E.D.F. within a development program carried out in common with Alsthom. This procedure is described and some results are mentioned concerning no-load settling, load-shedding, no-load three-phase short-circuit, pendular oscillations and field magnet transition.

57269 Few aspects of the behavior of a cryogenerator in a big electric system. Marquet, A. (Electr de Fr). *Rev. Gen. Electr.;* 85: No. 12, 971-979(Dec 1976). (In French).

The problem of comparison, in different operating conditions, of the evolution of the electric parameters of systems comprising either cryogenerators or conventional turbogenerator sets is considered. It is argued that it can be approached by showing, for different simplified or actual systems, selected according to the operating difficulties they involve, the behavior differences in regular operation or in disturbed conditions recorded with either machine. It is found that cryogenerators can render similar services to those required at present from conventional equipment and that they may offer some advantages in order to solve the stability problems raised by the evolution of the shape of the interconnected systems which appears at the present time.

57270 Some aspects of the cryogenics of a superconducting generator. Berther, M. (Cis Gen d'Electr, Lab de Marcoussis, Fr). *Rev. Gen. Electr.;* 85: No. 12, 987-997(Dec 1976). (In French).

The cryogenics of a 1 to 2 GW power plant superconducting generator using a niobium-titanium inductor is considered. After a general description of such a machine, the author defines several cooling systems depending on different thermodynamic conditions of inlet helium. Refrigeration economy cannot disregard the cost of superconducting material. They are respectively depending on the choice of helium inlet temperature and on superconducting material temperature reached during a short-circuit. The range of this choice is tight, more especially as the difference between inlet helium and winding temperatures can reach about 2 K, and is difficult to reduce. A few features of cooling with supercritical helium of a rotor are presented. Main problems may be solved, but a test of a rotating cryogenic system is necessary.

57271 Cooling system intended for cryogenerators. Chovet, P. (Cent d'Etuee Cryog-Air Liq, Fr). *Rev. Gen. Electr.;* 85: No. 12, 998-1002(Dec 1976). (In French).

Helium cooling systems are considered. Cooling cycles with a periodical evolution and those with a permanent flow are described and some questions about the selection and the efficiency of the cycle are raised. On the one hand, the main constituents of a cooler, i.e. compressors, heat exchangers, pressure release valves and, possibly, cold circulating pumps are considered, and, on the other hand, their operating conditions. The gap that still exists between the units already made for large laboratories and the level required for their industrial application is pointed out.

PROTECTIVE STRUCTURES AND EQUIPMENT

REFER ALSO TO CITATION(S) 56543

HANDLING EQUIPMENT AND PROCEDURES

REFER ALSO TO CITATION(S) 55903

57272 (K/DD—1000) **Criticality safety survey computations of uranium hexafluoride freezer/sublimer tube lattices.** Taylor, R.G. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 27p. Dep. NTIS, PC A03/MF A01.

The ANISN computer code has been used at the Oak Ridge Gaseous Diffusion Plant to survey the nuclear properties of infinite UF_6 freezer/sublimer tube lattices immersed in hydrogen fluoride-moderated UF_6 over the 1.0 to 5.0% ^{235}U enrichment range. Refrigerant-114 (R-114) at various densities was present with each freezer/sublimer tube. Infinite-medium multiplication factors were also determined for homogeneous UF_6/HF and UF_6/R-114 systems. The survey provides a broad overview of the nuclear properties of UF_6 freezer/sublimers and guidance for future computations on specific designs of these units proposed for gaseous diffusion plant application at a maximum ^{235}U enrichment of 5%.

57273 (MLM—2438(OP)) **Role of the engineer in protecting personnel and the environment in the nuclear industry.** Braun, J.D. (Mound Lab., Miamisburg, Ohio (USA)). 1977. Contract EY-76-C-04-0053. 38p. (CONF-770672—1). Dep. NTIS, PC A03/MF A01.

From Society for Women Engineers conference; Cincinnati, Ohio, USA (23 Jun 1977).

The engineer plays a key role in protecting both people and the environment from the adverse effects of radioactive materials. The nature of the hazards and some of the problems associated with plutonium and tritium operations are discussed and the solutions provided by sound engineering facility design are shown. Facility designs have been required for operations involving ^{239}Pu, ^{238}Pu and ^{3}H, and the different properties of these isotopes require differing solutions to design problems.

57274 Reactivity enhancement in transportation and storage arrays due to fissile material density reductions. Koponen, B.L. (Univ. of California, Livermore). *Nucl. Technol.;* 34: No. 2, 242-248(Jul 1977).

Some storage and transportation arrays become more reactive when the fissile material density is reduced. This effect was calculated for arrays of shipping containers and for arrays of ^{235}U spheres. The reactivity enhancement is due mainly to increased utilization of thermal neutrons and reduction in neutron leakage resulting from the increased size of low-density units.

SHIPPING CONTAINERS

REFER ALSO TO CITATION(S) 56655

57275 (DP-MS—77-5) **Design of containers for shipping unirradiated LMFBR assemblies.** Langhaar, J.W. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1977. Contract EY-76-C-09-0001. 14p. (CONF-770611—26). Dep. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; New York, New York, United States of America (USA) (12 Jun 1977).

The shipping container is being designed by the Engineering Department of the Du Pont Company as part of a Savannah River Plant program of technical assistance to the ERDA Division of Reactor Development and Demonstration in the area of shipping radioactive materials. Preliminary evaluation was made for several different designs, including arrangements of two and four assemblies per container. Although some saving in shipping cost could be realized by having more than one assembly per container, consideration of operational difficulties, exposure of personnel to radiation, and risk of damage to an assembly during handling led to selection of a design having one assembly per container.

57276 (KY—665(Suppl.1)) **Safety analysis report on the "Paducah Tiger" protective overpack for 10-ton cylinders of uranium hexafluoride. Supplement 1.** Stitt, D.H. (Paducah Gaseous Diffusion Plant, Ky. (USA)). 20 May 1977. Contract W-7405-ENG-26. vp. Dep. NTIS, PC A03/MF A01.

This supplement details design changes made to the "Paducah Tiger" since the issue date of the SAR, June 16, 1976. A $^{3}/_{8}$-inch thick, 304L stainless steel plate has been added on the valve end of existing and future overpacks to provide increased puncture resistance and the overpack cavity has been modified to preclude incorrect loading of the type 48X cylinder. Temperature profiles of the "Paducah Tiger" during the 30-minute fire test are included.

57277 (MLM—2428) **Safety Analysis Report for Packaging (SARP): ATMX-500 Railcar nuclear packaging.** Griffin, J.F. Peterson, J.B.; Edling, D.A.; Blauvelt, R.K. (Mound Lab., Miamisburg, Ohio (USA)). 8 Jul 1977. Contract EY-76-C-04-0053. 46p. Dep. NTIS, PC A03/MF A01.

A Safety Analysis Report for Packaging (SARP) is described that makes available to all potential users the technical specifications and limits pertinent to the modification and use of the ATMX Railcars for which the Department of Transportation has issued Special Permit No. 5948. The SARP includes discussions of structural integrity, thermal resistance, radiation shielding and radiological safety, nuclear criticality safety, and quality control. Much of the information was previously published in a similar report. A complte physical and technical description of the package is presented. The packaging cnsists of a specially modified ATMX Series 500 Railcar loaded with DOT Specification steel drums or fiberglass coated plywood boxes. The results of the nuclear criticality safety analysis provide the maximum quantities of each fissile isotope which may be shipped as Fissile Class I in 30- and 55-gal drums. A limit of 5 g/ft^3 was established for wooden boxes. Design and development considerations regarding the packaging concept and modification of the ATMX-500 Railcar are presented. Tables, dimensional sketches, sequential photographs of the structural modifications, technical references, loading and shipping guidelines, and results of Mound Laboratory's experience in using this container are included. An internal review of this SARP was performed in compliance with the requirements of ERDA Manual Chapter 5201-Part V.

57278 (SAND—76-0427) **Shock and vibration environments for large shipping containers on rail cars and trucks.** Magnuson, C.F.; Wilson, L.T. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1977. Contract EY-76-C-04-0789. 58p. (NUREG—766510). Dep. NTIS, PC A04/MF A01.

The purpose of this study was to provide definitions of shock and vibration environment to which fissile material shipping containers may be exposed during normal shipment by truck and rail cars. The definitions of vibration, shock superimposed on vibration and rail coupling shock result from existing data. The dependence of shock environment, from rail coupling operations, on parameters like cargo weight and shock attenuation couplers was also studied using spring-mass models. These studies show that for rail cars equipped with standard draft gear, the cargo response decreases with increased cargo weight until the springs bottom out. For rail cars equipped with shock attenuation couplers, cargo weight has little effect on cargo response. The study also shows the importance of matching couplers and tiedown stiffnesses to decrease the cargo response. Vibration and shock data samples have been obtained during truck shipment of heavy cargo and the data will be presented in subsequent reports. Similar data need to be obtained for rail shipment of heavy cargo and during rail coupling operations with heavy cargo.

57279 **Design challenges of serving a maturing LWR industry's spent fuel transportation needs.** Waymire, G.R.; Nordahl, J.H. (Exxon Nuclear Co., Richland, WA). *Trans. Am. Nucl. Soc.;* **26**: 248(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57280 **LMFBR spent fuel transportation technology development.** Pope, R.B.; Allen, G.C.; Dupree, S.A.; Freedman, J.M. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.;* **26**: 249-251(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

MINING AND DRILLING EQUIPMENT AND FACILITIES

57281 (PB—264429) **Study to determine research and development needs in western mining. Final report.** Hustrulid, W. (Utah Univ., Salt Lake City (USA). Dept. of Mining, Metallurgical and Fuels Engineering). 2 Nov 1976. Contract J0155143. 112p. NTIS PC A06/MF A01.

An overall summary and the individual reports of eight workshops to determine research and development needs in western mining are presented. Problem areas are identified, and recommendations regarding priorities, funding sources, and prime movers are made.

LASERS

57282 (AD-A—037488) **The development of visible molecular lasers. Final report.** Zare, R.N. (Columbia Univ., New York (USA)). 31 May 1975. Contract N00014-67-A-0108-0038. 5p. NTIS PC A02/MF A01.

A basic research program is described that was initiated to collect information relevant to the construction of visible molecular lasers, whether these devices are to be pumped by electron excitation or by chemical means. Special attention was focused on the measurement of excited-state radiative lifetimes since the parameter plays such an important role in laser design.

57283 (AD-A—037734) **Investigation of coupling of field emission cold cathode guns for gas lasers. Final technical report.** Loda, G.; Meskan, D.A. (Systems Science and Software, Hayward, Calif. (USA)). 4 Feb 1977. Contract DAAH01-74-C-0624. 183p. NTIS PC A09/MF A01.

See also Rept. no. SSS-75-264, AD-A024 354.

The following topics are discussed: repetitive pulse cold cathode technology in system applications, grid controlled cold cathode guns: analysis and calculations, grid controlled cold cathode guns; measurements; and conceptual design for a 7.5-kW beam power cold cathode gun.

57284 (SAND—76-9300) **Performance characteristics of the Sandia atomic iodine laser (SAIL-1).** Padrick, T.D.; Palmer, R.E.; Palmer, M.A.; Riley, M.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 4p. (CONF-770629—2). Dep. NTIS, PC A02/MF A01.

From Conference on laser engineering and applications; Washington, District of Columbia, United States of America (USA) (1 Jun 1977).

Results needed to evaluate the atomic iodine laser as a candidate for laser fusion applications are presented. Oscillator performance and reliability, temporal pulse distortion and beam quality of amplified pulses, energy extraction efficiency and overall efficiency are discussed.

57285 (SAND—76-9310) **Requirements for optimum chemical recoverability in photolytically pumped atomic iodine lasers.** Fisk, G.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 3p. (CONF-770629—3). Dep. NTIS, PC A02/MF A01.

From Conference on laser engineering and applications; Washington, District of Columbia, United States of America (USA) (1 Jun 1977).

The effect of chemical kinetic processes on recoverability or iodine-atom-source molecules from a spent amplifier is reported. Optimum chemical recoverability is shown to be associated with short photolytic pumping times and small radical-radical association rate constants.

57286 (UCRL—76834) **Geometrical theory of nonlinear phase distortion of intense laser beams.** Glaze, J.A.; Hunt, J.T.; Speck, D.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 May 1975. Contract W-7405-ENG-48. 29p. Dep. NTIS, PC A03/MF A01.

Phase distortion arising from whole beam self-focusing of intense laser pulses with arbitrary spatial profiles is treated in the limit of geometrical optics. The constant shape approximation is used to obtain the phase and angular distribution of the geometrical rays

in the near field. Conditions for the validity of this approximation are discussed. Geometrical focusing of the aberrated beam is treated for the special case of a beam with axial symmetry. Equations are derived that show both the shift of the focus and the distortion of the intensity distribution that are caused by the nonlinear index of refraction of the optical medium. An illustrative example treats the case of beam distortion in a Nd:Glass amplifier.

57287 Discharge studies of the Ne-Cu laser. de Hoog, F.J.; McNeil, J.R.; Collins, G.J.; Persson, K.B. (Department of Electrical Engineering, Colorado State University, Fort Collins, Colorado 80523). *J. Appl. Phys.;* **48**: No. 9, 3701-3704(Sep 1977).

Spontaneous-emission and absorption studies of the Ne-Cu hollow-cathode laser are summarized. The major discharge processes operative in the Ne-Cu laser are outlined and the qualitative aspects of a proposed model of the Ne-Cu laser are discussed. Emphasis is placed on cathode sputtering as a source of copper atoms, and we demonstrate that copper densities of 10^{14} atoms/cm^3 are created via discharge sputtering.

57288 Frequency selection in gas lasers by means of the Faraday effect in the active medium. Voitovich, A.P.; Panteleev, S.V. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 4, 388-391(Apr 1977).

One of the modifications of methods of controlling the frequency spectrum of the emission based on a conversion of the frequency dependence of the refractive index of the active medium into a frequency dependence of the losses is investigated. The dependence of the losses on the angle of Faraday rotation of the plane of polarization in the active medium is employed. Zero rotation of the plane of polarization and, consequently, minimum losses for the selected frequency within the gain contour are obtained by the application of oppositely directed longitudinal magnetic fields of different value at two different parts of the active medium. Using the Jones matrix formalism an expression is obtained for the dependence of the losses on the angle of rotation. Experimental investigations are carried out on He—Ne lasers at wavelengths of 0.63μm and 3.39μm.

57289 Experimental investigation of He:Ne lasers stabilized by saturation absorption in iodine. Melnikov, N.A.; Privalov, V.E.; Fofanov, Y.A. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 4, 425-428(Apr 1977).

The stability and reproducibility of the wavelength were investigated for a laser with systems of automatic frequency control by saturation absorption of the first and third harmonics of the frequency modulating the resonator length.

57290 Power resonances of a two-mode ring laser. Danileiko, M.V.; Kozubovskii, V.R.; Nedavnii, A.P.; Shpak, M.T. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 4, 428-432(Apr 1977).

The effect of the formation of narrow, contrast power resonances is investigated theoretically and experimentally in a two-mode ring laser when the mode positions relative to the central transition frequency are symmetric. The phenomenon may be used to increase the stability and reproducibility of optical frequency standards and the resolving power of nonlinear laser spectroscopy.

57291 Ultrashort pulses from a distributed-feedback dye laser. Zaporozhchenko, V.A.; Rubinov, A.N.; Efendiev, T.S. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 2, 46-47(Feb 1977).

A relatively simple dye laser system is reported that can be employed to produce ultrashort pulses with tunable wavelength over a braod spectral range. A ruby laser is used as the pump.(AIP)

57292 Population inversion for $10^00—01^10$ and $02^00—01^10$ transitions of the CO_2 molecule with gasdynamic cooling. Karlov, N.V.; Orlov, A.N.; Petrov, Y.N.; Prokhorov, A.M. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 2, 49-50(Feb 1977).

The possibility of achieving lasing action at 14 and 16 μ in a CO_2 laser is considered. The population inversion is computed as functions of temperature and pressure for a system with subcritical mixing of gas flows not in thermal equilibrium.(AIP)

57293 Kinematic mode locking in a solid-state laser. Kravtsov, N.V.; Sidorov, V.A.; Susov, A.M. (M. V. Lomonosov Moscow State University). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 2, 50-51(Feb 1977).

Experimental results are presented from a study of kinematic mode locking in a cw YAG=Nd^{3+} laser using uniform translational motion of one of the cavity mirrors.(AIP)

57294 Generation of nanosecond pulses in high-pressure CO_2 lasers. Karlov, N.V.; Konev, Y.B.; Kochetov, I.V.; Pevgov, V.G. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 2, 67-69(Feb 1977).

Calculations are performed on the lasing kinetics of a CO_2 laser operating at a pressure of 10 atm and having a cavity 15 cm in length.(AIP)

57295 Mass spectra of the positive ions in the discharge plasma of CO and N_2O lasers. Volchenok, V.I.; Egorov, N.P.; Komarov, V.N.; Kurpriyanov, S.E.; Ochkin, V.N.; Sobolev, N.N. (L. Ya. Karpov Physicochemical Institute and P. N. Lebedev Physics Institute of the Academy of Sciences USSR, Moscow). *Sov. Phys. - Dokl. (Engl. Transl.);* **22**: No. 2, 85-87(Feb 1977).

The mass spectra and ion currents of the discharge plasma of CO and N_2O lasers are studied. The pressure dependence is reported as well as the ionization mechanisms.(AIP)

57296 Technology and spectral characteristics of Polish heterojunction lasers. Nakwaski, W.; Muszynski, Z. (Inst Technol Elektron N-PCN, Pol). *Arch. Elektrotech. (Warsaw);* **25**: No. 2, 481-487(1976). (In Polish).

Important results dealing with the technology and measurements of spectral characteristics of the first Polish heterojunction laser diodes are reported. A constant distribution of Al in Al/sub x/Ga/sub 1-x/As epitaxial solid solution layer as well as relatively small threshold current values were obtained. Spontaneous modes were also recorded due to the high quality of Fabry-Perot resonators.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 55573, 56270, 56562, 56639, 56643, 56758, 56780, 57255, 57328

57297 (TID—27676) **Study of the mean particle diameter as related to the particle size distribution and the heat transfer rate from tubes immersed in a fluidized bed.** Henry, R.N. (Idaho Univ., Moscow (USA)). Apr 1977. 76p. Dep. NTIS, PC A05/MF A01.

Thesis.

Heat transfer from electrically heated bare stainless steel tubes to an air-fluidized bed of glass beads was investigated. The glass beads were 90 percent true spheres and ranged from 0.074 to 1.19 mm in diameter. The inside diameter of the fluidizing vessel was 15.24 cm (6 in.). Five 250-W electrical heaters were strategically placed within the vessel to heat the bed material. Heat transfer rates were measured for particle size distributions whose "mean" values were the same even though one distribution was skewed toward smaller diameter particles, while the other distribution was skewed toward larger diameter particles. A comparison of the heat transfer rate between these two beds was used to determine if the heat transfer rate for a given bed could change even though the "mean" diameter for the particle distribution in that bed did not change. Eight mean particle diameter techniques (Average, Geometric, Hermonic, Length, Surface, Volume, Weight, and Volume-Surface) were studied, and changes in the heat transfer rate were identified for six of these techniques. Consistent changes in the heat transfer rate were not identified for the Weight and Volume-Surface mean particle diameter techniques. Heat transfer coefficients were also correlated with mean particle diameters and with empirical equations used to predict heat transfer coefficients.

57298 Two-phase flow-rate measurement with sharp-edged orifices. theoretical investigation. Lorenzi, A.; Muzzio, A. (Univ di Genova, Italy). *Termotecnica (Milan);* **31**: No. 3, 119-127(Mar 1977). (In Italian).

The use of standard sharp-edged orifices in the metering of two-phase mixtures is examined from the theoretical point of view. In order to evaluate the range of validity and accuracy of various calculation procedures so far proposed, these are briefly reviewed and compared. Furthermore a model is developed, whose predictions are shown to be in good agreement with the available experimental data.

57299 Unsteady expansions in homogeneous gas-liquid two-phase mixtures. Culotta, S.; Volpes, R. (Univ di Palermo, Italy). *Termotecnica (Milan);* **31**: No. 1, 24-30(Jan 1977). (In Italian with English abstract).

A theory is given for unsteady expansions in homogeneous gas-liquid two-phase mixtures flowing in straight, constant-section pipes. Two type of fluid mixtures are considered, with volumetric ratio Δ greater than 10 and Δ greater than 1000, respectively.

57300 Determination of the stability boundary of a laminar flow of steam with film boiling. Shemagin, I.A.; Lapshin, R.M. (Gor'kii Polytech Inst im. A.A. Zhdanov, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 1, 92-96(1977). (In Russian).

Stability of a laminar flow of steam with film boiling at a vertical surface is investigated. Relations are obtained permitting determination of the boundary of different forms of flow of the stream film.

57301 Investigation of drop settlement in two-phase boundary layer of a short plate. Ryzhkov, S.V.; Khmara, O.M. *Teploenergetika (Moscow);* No. 10, 78-80(Oct 1976). (In Russian).

Using a laser Doppler anemometer, an experimental investigation of the gas and liquid boundary layer of a short plate with cylindrical protrusions and without them is carried out. The averaged, lengthwise pulsational component of gas velocity and the relative concentration of drops in the wall-adjacent layer are measured. 13 refs.

57302 Hydraulic resistance of supporting throttling washers, installed in horizontal pipes, to two-phase flow. Gofaizen, A.V.; Gombolevskii, V.I.; Pugachev, A.L. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 10, 85-89(Oct 1976). (In Russian).

Boundaries of use of existing mathematical models of hydraulic calculations in application to steam and water mixture are determined.

57303 Motion of an evaporating drop in superheated steam flow. Korolenko, Yu.A.; Forostov, V.M. (Chelyabinsk Polytech Inst im. Lenin Komsomol, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 10, 143-148(Oct 1976). (In Russian).

Equations are obtained describing changes in relative velocity and the path of motion of an evaporating drop in a stream of low-parameter steam. These equations permit determination of relative velocity and drop coordinates prior to the moment of its evaporation.

57304 Frictional pressure drop in adiabatic high velocity two-phase flow. Kesper, B.; Chawla, J.M. (Univ Karlsruhe, Ger). *Forsch. Ingenieurwes.;* **42**: No. 6, 177-183(1976). (In German).

Experiments were performed to determine the frictional and total pressure gradient simultaneously in high velocity two-phase flow. The experimental results reveal different laws for the frictional pressure loss depending upon the intensity of mass flow rate, quality of the mixture etc. A new correlation for the frictional pressure loss is proposed for compressible, accelerated two-phase flow. The correlations known for low velocity two-phase flow were combined with the new one in order to predict the frictional pressure loss in the whole range of flow velocities.

57305 One-dimensional motion of highly wet steam in nozzles. Zysin, V.A.; Nevinskii, V.V.; Rozenblyum, V.I. *Energomashinostroenie;* No. 12, 36-37(1976). (In Russian).

Principal equations of two-phase flow are considered taking into account metastability, sliding, and surface energy. Results of calculation of a problem of motion of two-phase flow of highly wet steam are presented. The effects of the inlet parameters on the conditions of flow, the position of the critical section, and lengthwise distribution of parameters are discussed.

57306 Distribution of the density of induced current along the height of an operational duct on an electrodynamic pump. Fikus, F.; Wieczorek, T.W. (Politech Slaska, Pol). *Arch. Elektrotech. (Warsaw);* **25**: No. 2, 443-454(1976). (In Polish).

The construction and principles of operation of an electromagnetic pump for molten metal developed in Poland, are presented, along with a mathematical model. A vector potential is determined by the method of the Fourier integral. The vector potentials for inductor and eddy-currents are also determined. Based on boundary conditions, the density of eddy currents is calculated. The obtained theoretical results are compared with experimental data found in the literature. 7 refs.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 56314, 57208, 57314

57307 (EPRI-NP—461) **Assessment of thick section radiography. Final report.** Rundquist, D.E.; Sargis, D.A.; Cassapakis, C.G.; Orphan, V.J. (Science Applications, Inc., La Jolla, Calif. (USA)). Jun 1977. 155p. Dep. NTIS, PC A08/MF A01.

The advent of new high intensity, high-energy accelerators has expanded the usage of one of the oldest nondestructive testing methods—x-ray radiography. However, the detection and possible quantification of small defects in thick steel sections by high-energy x-ray radiography often requires the optimum sensitivity from the radiography system. Experimental approaches have primarily been responsible for developing radiography to the present state-of-the-art. A totally comprehensive experimental investigation of high-energy x-ray radiography is practically infeasible because (1) the physical processes are complex and interrelated, and (2) the detailed determination of system sensitivity to component changes would be very expensive and time consuming. Another method of comprehensively investigating high-energy radiography is to develop an analytic model. This approach is emphasized. The basis of the realistic analytic model is the use of radiation transport codes to accurately simulate the proper scattered and direct beam that interacts with the imaging system. The mathematical description of the individual system components is described as a prelude to a description of the integrated system model. The emphasis is, however, on calculational results such as: fractional contribution to image from incident beam; effect of beam filters; buildup factors; collimation effects; backscatter effects; and thickness sensitivity.

57308 (SAND—77-0526C) **Ultrasonic data acquisition, analysis, and display by minicomputer aided techniques.** Gieske, J.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 16p. (CONF-770903—3). Dep. NTIS, PC A02/MF A01.

From ASME energy technology conference on composites in pressure vessels and piping; Houston, Texas, United States of America (USA) (18 Sep 1977).

A minicomputer-based ultrasonic data acquisition and display system is described. The system consists of a PDP-11 minicomputer with peripheral modules necessary to program the computer, control a test, acquire data, store data, analyze and display data. An ultrasonic data acquisition interface module and a general purpose test control and data acquisition interface module are generally described. A number of computerized ultrasonic data displays of pulse echo flaw data, relative attenuation, and ultrasonic velocity data for a flywheel constructed of a Kevlar—Epoxy composite are included to illustrate the capabilities of the system in ultrasonically characterizing a material. 7 figures.

57309 Technique for measuring optical fiber transmission using the time dispersion of Cerenkov radiation. Franks, L.A.; Nelson, M.A.; Davies, T.J.; Lyons, P.; Golob, J. (EGandG, Santa Barbara Operations, Goleta, California 93017). *J. Appl. Phys.;* **48**: No. 9, 3639-3641(Sep 1977).

A technique based on measurement of time dispersion in a δ-function Cerenkov pulse has been developed for determining the attenuation coefficient $\alpha(\lambda)$ of low-loss optical fibers. The time domain amplitude distribution of the transmitted polychromatic pulse is transformed to the wavelength domain by accurate measurement of the differences in arrival times of spectral bands isolated by interference filters. Since the Cerenkov pulses are generated in the fiber by a short burst of relativistic electrons, $\alpha(\lambda)$ can be measured over a wide and continuous range of path lengths without breaking the fiber. The technique has been demonstrated over the 500—800-nm spectral region for fiber lengths up to 800 m.

57310 Conversion efficiency enhancement in neutron radiography. Harms, A.A. (McMaster Univ., Hamilton, Ontario). *Trans. Am. Nucl. Soc.;* **26**: 156(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57311 Fast-neutron gauging of polyurethane foam. Tsang, F.Y.; Alger, D.M.; Brugger, R.M. (Univ. of Missouri, Columbia). *Trans. Am. Nucl. Soc.;* **26**: 156-157(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57312 Modulation transfer functions for high-speed-motion neutron radiography systems. Bossi, R.H.; Robinson, A.H. (Oregon State Univ., Corvallis). *Trans. Am. Nucl. Soc.;* **26**: 157-158(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

SAFETY ENGINEERING

57313 (UCID—17456) **Proposed safety standards for ERDA trailers and other portable structures.** Lipska, A.E.; Welton, L.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 May 1977. 81p. Dep. NTIS, PC A05/MF A01.

Topics discussed include body and frame design and construction requirements, planning cnsiderations, thermal protection, heating and cooling systems, plumbing, electrical systems, fire safety, industrial safety and hygiene, identification of portable structures, and testing. (TFD)

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 57182

57314 (BDX—613-1295(Rev.)) **Monitoring sinusoidal vibration environments with a television system.** Davis, J.W.; Anderson, F.O.; Lookabill, H.J.; Taylor, R.D. (Bendix Corp., Kansas City, Mo. (USA)). Feb 1975. Contract EY-76-C-04-0613. 15p. Dep. NTIS, PC A02/MF A01.

The development and prove-in work of this experiment established a technology for using television equipment to monitor hybrid

microcircuits and other miniature assemblies in sinusoidal vibration environments. Production assemblies were run through sine vibration test sequences with television systems used to monitor the sequences. During the experiment different television lens systems were tried to obtain clean, sharp, highly magnified pictures of the assemblies being monitored. Successful monitoring of production assemblies during the experiment was accomplished, resulting in design changes to the assemblies and establishment of a television monitoring system.

57315 (ORNL/Sub—3961/2) **Study of low-frequency excess noise in hybrid thick-film resistors.** Baker, J.P.; Kennedy, E.J.; Tucker, R.W. Jr. (Tennessee Univ., Knoxville (USA). Dept. of Electrical Engineering). 23 Feb 1977. Contract W-7405-ENG-26. 108p. (TR-EE/EL—8). Dep. NTIS, PC A06/MF A01.

A method of measuring the excess low-frequency noise due to direct current in hybrid thick-film resistors is presented. Guidelines for low-noise design of thick-film resistors are also included. Excess noise is present in a resistor in addition to thermal noise when there is direct current flow in the resistor. An expression was developed to indicate the dependence of excess noise on resistor dimensions as well as direct current and frequency. Details of an experimental system for measuring excess noise from the thick-film resistors is shown. From the experimental data the ratio of excess noise to thermal noise was computed at each current level and frequency. Using this ratio the constants in the expression for excess noise were then determined. Among the 1k-ohm per square pastes, the DuPont 1631 type offered lowest excess noise characteristics of the four tested. The DuPont 1641 paste proved outstanding in the five 10K-ohm per square pastes tested. When trimming was required, the air-abrasive trim on the "top-hat" style resistor produced the least increase in excess noise.

SOLID WASTE PROCESSING PLANTS AND EQUIPMENT

57316 (PB—264471) **Solid waste disposal feasibility study for Richmond County, Georgia Board of Commissioners.** (Patchen, Mingledorff, and Associates, Inc., Augusta, Ga. (USA)). 20 Aug 1976. 65p. NTIS PC A04/MF A01.

This report is a study of the thermal reduction of Richmond County's municipal solid waste and the generation of steam and electricity as a useful produce of the heat generated compared to the system of total landfilling which the County is presently using. The current state of the art is applied throughout. The cost of landfilling all waste, as is being done, is developed in order to compare that cost with the cost savings which can be realized by the County if thermal reduction is adopted. Two alternatives for disposing of Richmond County solid waste are discussed in this study. The plan is a continuation of the present solid waste collection, storage and landfill disposal during this ten year plan.

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 55628, 55651, 55719, 55729, 55791, 56315, 56324, 57137

57317 Preparation of liquid fuels by gas atomization. Scholz, R.; Jeschar, R. (Tech Univ, Clausthal, Ger). *Arch. Eisenhuettenwes.;* 48: No. 3, 151-155(Mar 1977). (In German).

Efficient control of the conditions in the reaction chambers of industrial furnaces, boilers, or other high temperature reactors requires the determination of the pulsed exit flow of the burner. For gas atomization burners with a mist flow leaving the burner this means determination of the different phase velocities of gas (such as coke oven gas or air) and liquid (such as fuel oil or, in model tests, water). This is possible, according to a previous publication, if the exchange variable for the kinetic energy is known. A method is now proposed to estimate this theoretically. 11 refs.

57318 Investigation of visible and ultraviolet emission from fuel oil flames on an industrial scale. Beretta, F.; Chille, A.; D'Alessio, A.; Noviello, C. (Univ di Napoli, Italy). *Termotecnica (Milan);* 31: No. 2, 68-75(Feb 1977). (In Italian).

The absolute intensity of the emission from the initial zones of large oil flames were measured in the 2500-7500 A range. The most prominent banded structure is found to be the OH emission at 3064 A, while the continuum is due both to soot and coke particles. These trials indicate the possibility of using visible and uv spectral measurements for the remote sensing and the control of the individual flames in multiburners combustion chambers. 9 refs.

57319 Development of the burning process with different layouts of vortex burners. Shnitser, I.N.; Yur'ev, L.V.; Shapovalov, Yu.I.; Merezhko, V.P.; Plaksin, O.T. (Cent Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 11, 50-55(Nov 1976). (In Russian).

To determine the intensity of the development of the processes of mixing and ignition of p.f/air jets and, consequently, of the efficiency of coal burnout, a comparative study of combustion and heat transfer in half-opened TPP-210 and TPP-210A boilers, with two-tier and single-tier layout of burners with 35 and 70 MW heat capacity, is carried out. Measurements of the velocity and temperature fields, of gas composition, p.f. concentration, and of the content of combustibles in it are presented. The data show steam that generators with a close layout of burners is more economical. A further increase of the unit capacity of vortex burning devices to 200 MW with their single-tier layout is recommended for newly designed 800 MW, 1200 MW and bigger power units with liquid slag removal.

57320 Experimental investigation of residual fuel oil atomization by water injectors. Rybalko, V.K.; Madoyan, A.A.; Gorbanenko, A.D.; Keller, V.D. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 11, 77-79(Nov 1976). (In Russian).

A method of fuel oil atomization with superheated water using water and fuel oil injectors is described. Flowrate characteristics are described for cases where saturated or underheated water is discharged through injector nozzles. Likewise, their dispersion characteristics, dependent on the pressure of the atomizer, are given.

57321 Investigation of stability and breakup of particles of a material during fusion in a gas suspension. Kochetkov, O.P.; Troyankin, Yu.V.; Vishenskii, V.V. (Kaz Sci Res Inst of Power Eng, USSR). *Teploenergetika (Moscow);* No. 11, 82-84(Nov 1976). (In Russian).

The process of breakaway of droplets of a molten material from the surface of a rotating particle is established analytically and confirmed experimentally. This research is carried out with reference to the highly forced processes of combustion of pulverized coal fuel.

57322 Mathematical model to study the process of combustion of a stream of atomized liquid fuel as a control object. Delyagin, G.N.; Ivanov, Yu.V.; Evseeva, S.A. (Inst of Miner Fuels, USSR). *Teploenergetika (Moscow);* No. 9, 44-46(Sep 1976). (In Russian).

Interconnection between the variable component of integral radiation of a flow of burning fuel, considered as a parameter of optimization of the combustion process, and parameters of the operating process, and the process--fuel consumption, air excess coefficient, fuel atomization air pressure, and heat transfer load on the walls of the furnace volume--is considered. Quantitative relations are obtained making it possible to evaluate the effect of the parameters of the operating conditions of the process on the optimization parameter.

57323 Determination of balance temperatures along the gas tract of the boiler by means of reduced fuel characteristics. Pekker, Ya.L. (Moscow Power Eng Inst, USSR). *Teploenergetika (Moscow);* No. 9, 50-55(Sep 1976). (In Russian).

A method of calculation of balance temperature of flue gases in steam generators is given. It relies on the measurement of heat absorption convective elements of the unit (regarding the flowrate, pressure and temperature of the working medium) and is based on reduced fuel characteristics.

57324 Investigation of the three-dimensional thermal and stress strained state of a one-piece piston of the chn 21/21 diesel engine, using the finite element method. D'yachenko, N.Kh.; Kollerov, L.K.; Shabrov, N.N. *Energomashinostroenie;* No. 9, 24-26(1976). (In Russian).

Results of an analytical investigation of the title problem are considered. The analysis is carried out for a quarter section of the piston which is divided into 175 macroelements. The data considered help to form an idea about the working profile of the lateral surface of the piston for different longitudinal sections. This permits prediction of the magnitude of optimal working gaps between the piston and cylinder liner.

57325 Aerodynamic characteristics of swirling burners and burnout of pulverized coal spray with peripheral ignition. Shnitser, I.N.; Yur'ev, L.V.; Shapovalov, Yu.I. *Energomashinostroenie;* No. 9, 35-38(1976). (In Russian).

Results of an investigation in a horizontal plane from swirling burners of a TPP 210 boiler, given peripheral spray ignition, are presented. It is shown that the stability of the ignition of solid fuel is determined by the total consumption of the recirculating gases and does not depend in practice on their quantities in the inner (axial) and outer zones (near the wall and between the burners).

57326 Reduction of fuel consumption of a two-shaft gas turbine engine in idle run. Barskii, I.A. *Energomashinostroenie;* No. 10, 23-25(1976). (In Russian).

Methods of reducing fuel consumption of idling engines are considered. The most effective ways are the following: the use of

heat regeneration, reduction of the frequency of rotation of the compressor, auxiliary unit drive from the power turbine, application of nozzle control or gas by-pass.

57327 Operation of the furnace chamber of the tpp-312a boiler with single-tier layout of burners with the thermal capacity of 100 mw. Shnitser, I.N.; Yur'ev, L.V.; Veshnyakov, E.K.; Solov'ev, L.K.; Reznik, O.A.; Tkachuk, A.A.; Litovkin, V.V.; Kuryshko, G.I. *Energomashinostroenie;* No. 12, 8-12(1976). (In Russian).

Results of adjustment and investigation of the furnace chamber of a TPP-312 A boiler equipped with swirling burners with the thermal capacity of 100 MW are presented. The burners are laid out in one tier on opposite sides. The fuel burned is Donetsk gaseous coal dust with liquid slag removal. The tests show satisfactory operation of the boiler.

57328 Method of calculation of heat transfer from a working medium to the walls of the combustion chamber of a diesel engine. Kostin, A.K.; Mikhailov, L.I. *Energomashinostroenie;* No. 12, 15-17(1976). (In Russian).

A new method of calculation of heat transfer is presented taking into account the parameters of the working process and design characteristics of the engine. Results of a comparison between the theoretical and experimental data are given.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 55914, 57281

57329 (Y/OWI/SUB—4269/22) **Analysis of the custom design/fabrication/testing requirements for a large-hole drilling machine for use in an underground radioactive waste repository.** Grams, W.H.; Gnirk, P.F. (RE/SPEC, Inc., Rapid City, S.Dak. (USA)). 25 Oct 1976. Contract W-7405-ENG-26. 52p. Dep. NTIS, PC A05/MF A01.

An analysis of the fabrication and field test requirements for a drilling machine that would be applicable to the drilling of large diameter holes for the emplacement of radioactive waste canisters in an underground repository is presented. On the basis of a previous study in 1975 by RE/SPEC Inc. for the Oak Ridge National Laboratory, it was concluded that none of the commercially available machines were ideally suited for the desired drilling application, and that it was doubtful whether a machine with the required capabilities would become available as a standard equipment item. The results of the current study, as presented here, provide a definitive basis for selecting the desired specifications, estimating the design, fabrication, and testing costs, and analyzing the cost-benefit characteristics of a custom-designed drilling machine for the emplacement hole drilling task.

MARINE ENGINEERING

REFER ALSO TO CITATION(S) 55759

57330 Scaling of fixed off-shore structures. Dawson, T.H. (Naval Academy, Annapolis, MD). *Ocean Eng.;* 3: No. 6, 421-427(Dec 1976).

A simple scaling law is developed for fixed off-shore structures assuming linear structural response and using a Rayleigh correction to account for the structural mass. The accuracy of the law is examined by comparing its predictions with results from an analytic solution for the case of an idealized structure consisting of a rigid deck and uniform support cylinder. Results show agreement within 4 percent when the scale of the system is reduced a full order of magnitude.

PARTICLE ACCELERATORS

AUXILIARIES AND COMPONENTS

EXPERIMENTAL FACILITIES AND EQUIPMENT

57331 Precision position control and monitoring via CAMAC. Simanton, J.R.; Wegner, C. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.;* NS-24: No. 1, 840-842(Feb 1977).

Devices such as targets and collimators installed in experimental beam lines of the Fermilab Proton Accelerator require precise remote positioning and monitoring under computer control. Since September, 1973, these and similar applications have been handled by a CAMAC Target Position/Monitor module designed by the Beam Systems Control Group. Numerous features have been incorporated into hardware and software to assure position and input data integrity, and to eliminate hunting, gear-train backlash errors, and direction-change ambiguity. The module controls the device's drive motor via relay closures. Data inputs for the monitoring function consist of a pulse-train generated by a shaft encoder, plus limit and reference switch contacts. Resolution is 16 bits (approximately 1 part in 65,000) or 15 bits either side of center. In addition to its normal positioning functions, the module has found application in facilities which provide precision, on-the-fly, computerized magnetic-field mapping, for programming, monitoring, and policing the motions of a large, multi-arm spectrometer, and as a component in computerized laser alignment equipment.

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 56391, 56759, 57788

57332 Ge(Li) system for the monitoring of low level radioactive gases. Jester, W.A.; Hepburn, F.J. (Pennsylvania State Univ., University Park). *Trans. Am. Nucl. Soc.;* 26: 121(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57333 Informational threshold of sensitivity of radiation detectors. Ivanenko, V.D. *Opt. Spectrosc. (USSR) (Engl. Transl.);* 42: No. 4, 408-410(Apr 1977).

Using information theory methods with a Poisson distribution of quanta for the signal and background, threshold values are obtained for the absolute and contrast sensitivities of radiation detectors in a 2-D observation field. Using a human visual analyzer as an example, a comparison is made of the theoretical and experimental threshold signals.

57334 Activity measuring point, especially in a nuclear power station. Fickert, W.; Kuhn, L. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,446,347/A/. 15 Apr 1976. 9p. (In German).

2 figs.

An activity measuring point for a gaseous radiation emitting medium is described using - with a slowly changing background - a detector measuring pulses with a given calibration factor and a ratemeter which integrates the measured pulses and yields a value, logarithmically assigned to the integral, for an indicating instrument whose beginning of scale is adjustable within the range of at least a decade. A pulse-giving device is assigned to the detector generating pulses of adjustable number which are subtracted except for a remaining background from the pulse-rate determined by the detector. The product of remaining background and calibration factor determining the scale can thus be set to a desired value for adjustment to the background radiation.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

57335 (IS—4169) Users guide to finger, thumb, and triple axis real time experiment control programs. Pinter, T.G.; Notis, E.M. (Ames Lab., Iowa (USA)). Apr 1977. Contract W-7405-ENG-82. 52p. Dep. NTIS, PC A04/MF A01.

This manual provides the user with instructions for using the real time control system for the neutron scattering spectrometers: finger, thumb, and triple axis. The input requirements of the various programs are described in detail. Logging on procedures, program loading, and data set organization are also discussed.

57336 (UCRL—79376) MOS solid-state detector arrays for x-ray imaging. Koppel, L.N. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Apr 1977. Contract W-7405-ENG-48. 7p. (CONF-770434—1). Dep. NTIS, PC A02/MF A01.

From SPIE x-ray imaging symposium; Reston, Virginia, United States of America (USA) (20 Apr 1977).

Two types of MOS detector arrays were used to sense directly patterns of soft x-rays, in the Lawrence Livermore Laboratory experimental laser-fusion program. A linear self-scanning photodiode array (SSPA) is used in a wave-length-dispersive spectrometer. A frame transfer charge-coupled device (CCD) facilitates the use of an x-ray microscope. Measurements and calculations of the x-ray sensitivity of these devices are presented. Their linearity and dynamic range are discussed, as well as data recovery systems for each detector. Experiences in using these devices to detect pulses of x-rays in laser-fusion experiments are described.

RADIOMETRIC INSTRUMENTS

REFER ALSO TO CITATION(S) 55714

57337 Application of in situ analysis to hydrogen-related materials problems. Adler, P.N. (Grumman Aerospace Corp., Bethpage, NY). *Trans. Am. Nucl. Soc.;* **26**: 145-146(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57338 Profiling hydrogen and helium in materials using ion beams. Ziegler, J.F. (IBM-Research, Yorktown Heights, NY). *Trans. Am. Nucl. Soc.;* **26**: 146-147(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57339 Density measurements in a burning cigarette. Williamson, T.G. (Univ. of Virginia, Charlottesville); MacKinnon, J.G.; Jenkins, R.W.; Frisch, A.F. *Trans. Am. Nucl. Soc.;* **26**: 165(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 55680, 55726, 55861, 57156, 57194, 57201, 57202, 57203, 57308

57340 (LA—6812-PR) Passive electronic identification and temperature monitoring system. Progress report, January—December 1976. Bobbett, R.E.; Koelle, A.R.; Landt, J.A.; Depp, S.W. (Los Alamos Scientific Lab., N.Mex. (USA)). Jul 1977. Contract W-7405-ENG-36. 25p. Dep. NTIS, PC A02/MF A01.

A six-digit microwave telemetry system is described in which a passively powered transponder can be remotely interrogated to report temperature and identification. This preprototype system was developed to be used to identify livestock and monitor temperature by implanting the transponder unit under the skin of each animal. Expected benefits include early warning of disease or other stress conditions and improved animal management.

57341 Infrared upconverter for astronomical imaging. Boyd, R.W.; Townes, C.H. (Department of Physics, University of California, Berkeley, California 94720). *Appl. Phys. Lett.;* **31**: No. 7, 440-442(1 Oct 1977).

An imaging upconverter has been constructed which is suitable for use in the study of the thermal 10-μm radiation from astronomical sources. The infrared radiation is converted to visible radiation by mixing in a 1-cm-long proustite crystal. The phase-matched 2-cm^{-1} bandpass is tunable from 9 to 11 μm. The conversion efficiency is 2 x 10^{-7}, and the field of view of 40 arc seconds on the sky contains several hundred picture elements, approximately diffraction-limited resolution in a large telescope. The instrument has been used in studies of the sun, moon, Mercury, and VY Canis Majoris.

57342 Derivation and testing of a model to calculate electrical shunting and leakage errors in sheathed thermocouples. Roberts, M.J.; Kollie, T.G. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Rev. Sci. Instrum.;* **48**: No. 9, 1179-1191(Sep 1977).

A three-wire transmission line model was derived to calculate temperature measurement errors caused by electrical shunting and leakage in metal sheathed, oxide insulated, compacted thermocouple assemblies. Input parameters for the model were measured and used to verify experimentally the validity of the model on a 0.5-mm-diam stainless steel sheathed, MgO insulated, Chromel/Alumel thermocouple assembly. When a 1.27-m length of the assembly was heated to 1274 K, the errors due to shunting, calculated using the model, were 6.4% and 9.4% lower than the experimentally measured errors for theromocouple measuring junction temperatures of 273.2 and 371.5 K, respectively. With the 1.27-m length heated to 1373 K, the errors due to shunting, calculated using the model, were 12.6% and 14.9% lower than the experimentally measured errors for measuring junction temperatures of 273.2 and 371.5 K, respectively. For a 1.27-m length of the thermocouple assembly at 1274 K, the measuring junction at 273.2 K, and sheath currents of 20, 40, 60, and 80 mA, the error due to leakage, calculated using the model, was within 6% of the experimentally measured error. With the 1.27-m length heated to 1373 K and all other conditions the same, the calculated error due to leakage was within 9.1% of the measured error. This paper describes the experimental apparatus and measurements, explains the method used to infer parameters from experimental measurements, presents the model, and derives the differential equations that describe the electrical phenomena. These equations are solved exactly for a uniform line. A fortran IV coded numerical solution for nonuniform lines is described. Several illustrative examples are presented to clarify the concepts involved in electrical shunting.

57343 Simple goniometer for precise grinding and electropolishing of single crystal surfaces. Wendelken, J.F.; Withrow, S.P.; Foster, C.A. (Coordinated Science Laboratory, University of Illinois, Urbana, Illinois 61801). *Rev. Sci. Instrum.;* **48**: No. 9, 1215-1216(Sep 1977).

A simple goniometer, which can be used to rigidly support a crystal in a precise orientation through all phases of surface preparation, including mechanical, chemical, and electrochemical polishing, is described.

57344 Comparative analysis of measuring instruments with evaluation of errors of determination of principal parameters in model tests of hydraulic turbines. Sidorenko, V.F. *Energomashinostroenie;* No. 9, 39-41(1976). (In Russian).

The methods and techniques of measurements implemented during model tests of hydraulic turbines are analyzed, and metrological evaluation of the measuring instruments is made. Particular attention is paid to the main trends in the development of the methods and technologies of measurement during model tests as well as to modern measuring instruments. Recommendations are made regarding the selection and use of measuring instruments and processing of the results when determining principal parameters in the course of model tests of hydraulic turbines.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

57345 (LA—6873-MS) Influence of metals on the thermal decomposition of s-triaminotrinitrobenzene (TATB). Loughran, E.D.; Wewerka, E.M.; Rogers, R.N.; Berlin, J.K. (Los Alamos Scientific Lab., N.Mex. (USA)). Jul 1977. Contract W-7405-ENG-36. 7p. Dep. NTIS, PC A02/MF A01.

Although s-triaminotrinitrobenzene (TATB) possesses unusually high thermal stability for an organic explosive, the rate of gas evolution at elevated temperatures appears to be increased markedly by the presence of copper, iron, or brass. Aluminum in the same experimental environment produces little or no effect on the gas evolution rate. Results of various experiments in which attempts were made to evaluate the magnitude of the effects and to elucidate the mechanism of the thermal degradation of TATB both in the pure state and in the presence of the aforementioned metals are presented.

57346 (LA-UR—77-1378) LASL methods for derivation of predictive models for explosives thermal hazards and lifetime. Rogers, R.N. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 5p. (CONF-770635—3). Dep. NTIS, PC A02/MF A01.

From Conference on the standardization of safety and performance tests for energetic materials; Dover, New Jersey, United States of America (USA) (21 Jun 1977).

Sensitivity, thermal stability, and toxicity are the three major safety factors that must be considered in selecting an explosive for any specific application. The procedures used at LASL to obtain quantitative data on the thermal stability of any new explosive system are discussed. (TFD)

57347 (MHSMP—77-20) TATB formulation study. Final report. Crutchmer, J.A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Jun 1977. Contract W-7405-ENG-48-500-016;EY-76-C-04-0487. 17p. Dep. NTIS, PC A02/MF A01.

The physical characteristics of several TATB formulations were investigated for use in booster pellets. These formulations included fine particle size TATB, without binder and with 1% Kel-F binder and 2% Kel-F binder. Corresponding tests were performed on RX-03-BB (7.5% Kel-F) for comparison. Test samples from each formulation were prepared for thermal cycling, moisture resistance, compression, indirect tensile and density gradient.

57348 (UCID—17540) Equations of state for detonation products of high energy PBX explosives. Lee, E.L.; Helm, F.H.; Finger, M.; Walton, J.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Aug 1977. Contract W-7405-ENG-48. 25p. Dep. NTIS, PC A02/MF A01.

It has become apparent that the accumulated changes in the analysis of cylinder test data, in the material specifications, and in the hydrodynamic code simulation of the cylinder test necessitated an update of the detonation product EOS description for explosives in common use at LLL. The explosives reviewed are PBX-9404-3, LX-04-1, LX-10-1, LX-14-0 and LX-09-1. In order to maintain the proper relation of predicted performance of these standard explosives, they have been revised as a single set.

57349 (UCRL—79391) **Explosive testing at the Lawrence Livermore Laboratory: philosophy and practice.** Kury, J.W.; James, E.; Dobratz, B.M.; Finger, M.; Green, L.G.; Lee, E.L.; McGuire, R.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Jun 1977. Contract W-7405-ENG-48. 13p. (CONF-770635—4). Dep. NTIS, PC A02/MF A01.

From Conference on the standardization of safety and performance tests for energetic materials; Dover, New Jersey, United States of America (USA) (21 Jun 1977).

The evolution of explosives testing at the Lawrence Livermore Laboratory is discussed. The areas of performance, shock initiation, stability, mechanical properties and safety are addressed with emphasis on the standardization of tests.

NUCLEAR

REFER ALSO TO CITATION(S) 57212

CIVIL USES

REFER ALSO TO CITATION(S) 57379

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

57350 (NP—21685) **Bibliography on precipitation chemistry (subject index).** Asman, W.A.H.; Conrads, L.A. (Rijksuniversiteit Utrecht (Netherlands). Instituut voor Meteorologie en Oceanografie). 1975. 113p. Dep. NTIS (US Sales Only) $5.50.

This bibliography of 1470 references on atmospheric precipitation chemistry covers the period 1950 to 1975. (DLC)

BASIC STUDIES

REFER ALSO TO CITATION(S) 56922

57351 (ORNL—5151) **Rainfall simulation for environmental application.** Shriner, D.S.; Abner, C.H.; Mann, L.K. (Oak Ridge National Lab., Tenn. (USA)). Aug 1977. Contract W-7405-ENG-26. 17p. Dep. NTIS, PC A03/MF A01.

Rain simulation systems have been designed for field and greenhouse studies which have the capability of reproducing the physical and chemical characteristics of natural rainfall. The systems permit the simulation of variations in rainfall and droplet size similar to that of natural precipitation. The systems are completely automatic and programmable, allowing unattended operation for periods of up to one week, and have been used to expose not only vegetation but also soils and engineering materials, making them versatile tools for studies involving simulated precipitation.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 55654, 55656, 55791, 57086, 57461

57352 (BNL—50637) **Individual air pollution monitors. 2. Examination of some nonoccupational research and regulatory uses and needs.** Morgan, M.G.; Morris, S.C. (Brookhaven National Lab., Upton, N.Y. (USA)). Jan 1977. Contract EY-76-C-02-0016. 11p. Dep. NTIS, PC A02/MF A01.

Knowledge of the relationship between ambient air pollution levels measured at fixed monitoring stations and the actual exposure of the population is very limited. Indeed, there is rapidly growing evidence that fixed-station monitors do not provide adequate data for population exposure. This report examines available data for carbon monoxide (CO) and sulfur dioxide (SO_2) and presents a new analysis. Actual population exposure to CO appears to be consistently higher than expected from fixed-station data, while limited evidence suggests that exposures to SO_2 are lower. A reported general relationship between indoor and outdoor levels of SO_2 is not supported by the data. If air pollution represents a threat to public health, then more attention must be given to total population exposure to pollutants. A selective use of individual air pollution monitors that can be worn or carried appears to be required at some stage by any experimental design seeking to uncover the relation between air pollution exposure and health effects. Additionally, potential uses of individual monitoring in air pollution regulation are explored. Current status and research needs for individual air pollution monitors are examined and a first-order evaluation is given of the promise held by the candidate instrumentation technologies. A national program of support for the development of individual air pollution monitors is recommended.

57353 (COO—3573-26) **Fate of nuclides in natural water systems. Annual progress report, October 1, 1976—September 30, 1977.** Turekian, K.K. (Yale Univ., New Haven, Conn. (USA). Dept. of Geology and Geophysics). 30 Jun 1977. Contract EY-76-S-02-3573. 9p. Dep. NTIS, PC A02/MF A01.

Directly or indirectly man's spewing of his wastes into the coastal zone is coupled to his use of energy. The act of supplying energy for his ongoing activities is capable also of supplying some of the potentially most deleterious components to the coastal zone. Results are reported from studies of the pattern of physical and biological activity in the estuary which controls the distribution and possible neutralization of potential pollutants. Sediment chronologies applicable to aqueous repositories were established in order to identify the effects due to man and to assess the changing intensity of his activities over time. Natural and manmade radionuclides have been commonly used to identify age with depth in the sediment pile, but we find that processes other than sediment accumulation confound the record. Biological and physical disruptions that alter the record of radionuclides in a sediment from that expected from the source were studied in Long Island Sound using the natural radionuclides ^{234}Th and ^{210}Po and trace elements Zn, Cd, Cu, and Ni. The uptake and retention of these elements in mussels was studied.

57354 (EPA—450/1-77-003) **National trends in trace metals in ambient air, 1965—1974.** Faoro, R.B.; McMullen, T.B. (Environmental Protection Agency, Research Triangle Park, N.C. (USA). Monitoring and Data Analysis Div.). Feb 1977. 28p. GPO.

This report examines trends over the past 10 years (1965 to 74) in ambient concentrations for 11 metals: beryllium, cadmium, chromium, copper, cobalt, iron, lead, manganese, nickel, titanium, and vanadium. The trends are derived from samples collected from 92 urban and 16 nonurban hi-vol stations in the National Air Surveillance Network. For purposes of presentation, the trace metals were grouped into two broad categories: the metals related to fuel combustion and those related to industry. Possible reasons for the trends observed are given for most of the metals studied.

57355 (LBL—5214) **Atmospheric aerosol research. Annual report, 1975—1976.** Novakov, T.; Bekowies, P.J.; Chang, S.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1976. Contract W-7405-ENG-48. 72p. Dep. NTIS, PC A04/MF A01.

The present program can be divided into three main areas of research: chemical characterization of atmospheric aerosols with emphasis on nonphotochemical reactions involving SO_2, NO, HN_3, and soot particles; studies of reaction mechanisms; and field studies. The contributions made during the last year in each of these areas are described.

57356 (PB—264362) **Technical support to the state of Connecticut in development of an air quality maintenance plan. Final report.** Siegel, R.D. (Abcor, Inc., Cambridge, Mass. (USA). Walden Research Div.). Feb 1977. Contract EPA-68-02-1377. 54p. (C—504-6-2). NTIS PC A04/MF A01.

As part of the development of an air quality maintenance plan (AQMP) for the state of Connecticut, an update of the state's point source emission inventory to 1975 is required. Walden was retained by the Environmental Protection Agency (EPA) to assist the state in this task, with a specific requirement to update fuel use and combustion information for approximately 2500 point sources. Update information was collected by an emission source survey. This data was coded in STARTER format and forwarded to the Connecticut Department of Environmental Protection (DEP) for introduction into their inventory system.

57357 (PB—264822) **The chemistry, dispersion, and transport of air pollutants emitted from fossil fuel power plants in California: data analysis and emission impact model. Final report.** Liu, M.; Durran, D.; Mundkur, P.; Yocke, M.; Ames, J. (Systems Applications, Inc., San Rafael, Calif. (USA)). 15 Sep 1976. Contract ARB-4-258. 336p. (EF—76-18R). NTIS PC A15/MF A01.

The California Air Resources Board sponsored a monitoring and analysis program to study the effects on air quality of using high-sulfur fuels in power plants. As a part of this effort, three mathematical models were developed. The Reactive Plume Model (RPF), adopting a trajectory approach, accommodates variations in wind speed, plume spread, and ambient concentrations. A kinetic mechanism was used to describe gas-phase reactions between NOx, SOx, and hydrocarbons. The Buoyant Plume Model (BPM) predicts plume rise and effluent dispersion near the stack. It invokes the Navier-Stokes equation with the Boussinesq approximation, and allows for plume-generated turbulent diffusion. The Plume Dispersion Model (PDM) simulates pollutant distributions far downwind, PDM solves the three-dimensional atmospheric diffusion equation, and incorporates variations in wind speeds.

57358 (PB—264823) **The chemistry, dispersion and transport of air pollutants emitted from fossil fuel power plants in California: chemical analysis of particulate samples for sulfate, nitrate, and trace element composition. Final report, Sep—Nov 1974.** Appel, B.R.; Wall, S.M.; Wesolowski, J.J. (California Dept. of Health, Berkeley (USA). Air and Industrial Hygiene Lab.). Feb 1976. Contract ARB-3-948. 100p. (CA/DOH/AIHL/SP—5). NTIS PC A05/MF A01.

See also PB—254449.

The formation of sulfate and nitrate in SF_6-labelled power plant plumes emitted to otherwise clean and relatively polluted atmospheres. Results from field monitoring conducted in the vicinity of the Moss Landing power plant were compared to those from sampling the plumes from the Haynes and Edison power plants at Alamitos Bay. Ground level sampling employed an array of automated sequential particulate samples, SO_2 and SF_6 monitors. Aerial particulate collection within and adjacent to the plume was also employed. Particulate nitrate levels in ground level samples at both sites appeared to be independent of the plumes under study. Sulfate concentrations, however, did reveal contributions from the plumes except when sulfate levels were high (e.g. < 30 micrograms/cu m). The sulfate contribution from the Southern California plumes were calculated to be 3-5 microgram/cu m at ground level compared to 1.6-2.3 microgram/cu m from the Moss Landing plant. Based on aerial sampling, concentrations of sulfate at varying distances downwind of the stack ranged from 0.9 to 14.9 microgram/cu m. However the sampling protocol did not permit calculation of plume sulfate levels and, therefore, SO_2 conversion. A procedure is described for calculating SO_2 conversion in the plume which may be of use in future programs.

57359 (PB—265101) **Predicted transport of air pollutants from the Navajo and Kaiparowits generating stations into Lake Powell.** Walther, E.G. (Lake Powell Research Project, Los Angeles, Calif. (USA); Charles F. Kettering Foundation, Dayton, Ohio (USA); California Univ., Los Angeles (USA). Inst. of Geophysics and Planetary Physics). Aug 1976. 48p. (Bull—26). NTIS PC A03/MF A01.

Report on Collaborative Research on Assessment of Man's Activities in the Lake Powell Region. Prepared by Charles F. Kettering Foundation, Dayton, Ohio. Prepared in cooperation with California Univ., Los Angeles. Inst. of Geophysics and Planetary Physics.

This bulletin presents a theoretical and numerical analysis of the flow of 40 different substances in coal through combustion equipment in two large-scale thermal-electric generating stations, air pollution control devices, and tall stacks into the atmosphere. Meteorological data are then used to calculate the transport of these substances over nearby Lake Powell and their deposition into the lake and on the surrounding drainage basin. The complete systematic analysis predicts the concentrations of these substances expected in the water of the lake, assuming no partition onto sediments, and compares them with existing concentrations and the lowest concentrations detectable with current instrumentation. Calculations for this specific case indicate that only mercury may be added in concentrations sufficiently high to exceed some measured background concentrations, and possibly high enough to be worrisome. The conceptual framework of this analysis includes deposition, the important and often neglected process that connects airborne dispersion with effects at the earth's surface.

57360 (PB—265381) **Fiscal year 1976/health and environmental effects research program abstracts.** Gerard, A.; Mavraganis, P.; Dixon, K.; Holte, H. (Automation Industries, Inc., Silver Spring, Md. (USA). Vitro Labs. Div.). Dec 1976. Contract EPA-68-01-2934. 383p. NTIS PC A17/MF A01.

Report on Federal Interagency Energy/Environment Research and Development Program.

This report includes SSIE (Smithsonian Science Information) Abstracts pertaining to the FY 1976 Interagency Energy/Environment Research, Development and Demonstration Program being coordinated and managed by EPA's Office of Energy, Minerals, and Industry. The Abstracts are organized by major health and ecological research categories. This volume includes research being accomplished by EPA and its laboratories as well as a number of other participating agencies of the Federal Government.

57361 (PB—265382) **Mesoscale air pollution transport in southeast Wisconsin. Final report 1972-1976.** Lyons, W.A. (Wisconsin Univ., Milwaukee (USA). Air Pollution Analysis Lab.). Feb 1977. 238p. NTIS PC A11/MF A01.

This research program comprised a comprehensive study of mesoscale meteorological regimes on the western shore of Lake Michigan and their effect upon air pollution dispersion and transport. It is felt that the results are applicable in a generic way to other mid-latitude coastal zones. Continuous fumigation from elevated sources in shoreline zones during stable daytime onshore flow was intensively investigated by a large scale field program. A model was proposed, constructed, validated and calibrated. It was shown that the fumigation spot, while causing very high surface SO_2 concentrations, was so highly mobile as to generally reduce dosages below the three-hour standard (at least for the plants studied). An intensive case study of a lake breeze was performed. Data were used as input to a Kinematic Diagnostic Model (KDM) which simulated mesoscale trajectories for pollutants released within the coastal zone. Both mesoscale and synoptic scale transport of photochemical oxidants were found to be a significant problem in the Milwaukee area.

57362 (PPSP-CPCTP—12(Vol.1)) **Chalk Point Cooling Tower Project. Volume 1. Phase IV, comprehensive field program description. Environmental Systems Corporation's comprehensive project final report, October 1, 1975—June 30, 1976.** (Environmental Systems Corp., Knoxville, Tenn. (USA). Engineering Projects Div.). Apr 1977. Contract EY-76-C-02-2381. 280p. Dep. NTIS, PC A13/MF A01.

Results of a field measurement program conducted as part of the Chalk Point fossil-fuel power plant cooling tower project for the fiscal year 1976 are presented in two volumes. Source measurements of droplet size and mineral mass emission were conducted in the Unit 3 natural draft cooling tower and scrubber stack together with downwind measurements of a number of parameters including droplet size during two Intensive Monitoring Periods (Seasonal Tests). In addition, results are presented of continuous monitoring measurements wherein downwind sodium concentration, cooling tower droplet size measurements and time-lapse plume photography were acquired. On-site meteorological data was also acquired over the report period and is presented in summary form. A portion of the first seasonal test data was used as input to drift transport models as a first step in model verification and determination of stack drift interference with measurements aimed at determining downwind cooling tower contributions.

57363 (PPSP-CPCTP—12(Vol.2)) **Chalk Point Cooling Tower Project. Volume 2. Summer seasonal test data. Environmental Systems Corporation's comprehensive project final report, October 1, 1975—June 30, 1976.** (Environmental Systems Corp., Knoxville, Tenn. (USA). Engineering Projects Div.). Apr 1977. Contract EY-76-C-02-2381. 278p. Dep. NTIS, PC A13/MF A01.

Tabulated data are presented from air monitoring studies in the vicinity of the Chalk Point fossil-fuel power plant located in a coastal region of Maryland. (CH)

57364 **Lidar observations of plume diffusion at Rancho Seco Generating Station.** Uthe, E.E. (Stanford Univ., CA) Johnson, W.B.; Till, H.A. *Trans. Am. Nucl. Soc.;* **26**: 121-122(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57365 **Oxidant control strategies. Part I. Urban oxidant control strategy derived from existing smog chamber data.** Dimitriades, B. (Environmental Research Center, Research Triangle Park, NC). *Environ. Sci. Technol.;* **11**: No. 1, 80-88(Jan 1977).

Data from one smog chamber study of oxidant—precursor relationships are reanalyzed, and diagrams depicting the quantitative dependence of maximum 1-h oxidant concentration on the nonmethane hydrocarbon and nitrogen oxides (NO/sub x/) reactants are derived. A method is described by which these diagrams can be used to design an optimum control strategy for urban oxidant reduction. Advantage of this smog chamber method over the presently used aerometric data analysis method is that it considers the role of NO/sub x/ quantitatively. Thus, hydrocarbon control requirements calculated by this method depend on ambient NO/sub x/ concentration and can be minimized by controlling NO/sub x/ to an optimum maximum level. Advantages and limitations of this smog chamber method are discussed, and suggestions for improvement are offered.

57366 **Tracking pollutants from a distance.** Melfi, S.H. (Environmental Protection Agency, Las Vegas, NV); Koutsandreas, J.D.; Moran, J. *Environ. Sci. Technol.;* **11**: No. 1, 36-38(Jan 1977).

Reviewed briefly are several techniques for remote sensing of pollution being used to gather legally defensible data used by the EPA to meet its monitoring requirements. (JWP)

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 57212

57367 (STH—6/76) **Status report on environmental radioactivity monitoring in the Federal Republic of Germany.** Riedel, H.; Huber, O. (Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Strahlenhygiene). Sep 1976. 101p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

With figs. and tabs.

The status report on environmental radioactivity monitoring presented here is based on the data collected by the light control

stations in 1975. The duties of the control stations, the measuring stations assigned to them and their measuring programs, analyses, and methods of measurement are documented in detail. The increasing development of nuclear energy in the FRG brings about new duties of monitoring the environmental radioactivity; especially from the new radiation protection regulation and the regulatory guide 'Measures for Monitoring the Environment of Nuclear Power Stations with Light-Water-Cooled Reactor', issued by the 'Laenderausschuss fuer Atomkernenergie' (Land committee for nuclear energy) already in 1974, a number of additional requirements for the control and measuring stations can be derived. The aim of this report is to allow a judgement on how the network of measuring stations, established during the nuclear weapons' tests in the fifties and sixties, is equipped in operative and personnel respect and to what extend the methods of analysis and measurement used by them meet the new requirements. In principle, it may be stated, in addition, new standardized methods of measurement have to be introduced and applied in routine work in order to adapt the immission monitoring to the new dose limits for the environsment of nuclear installation.

57368 (UCID—17490) **Operators guide: Atmospheric Release Advisory Capability (ARAC) site facility.** Lawver, B.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Jul 1977. Contract W-7405-ENG-48. 16p. Dep. NTIS, PC A02/MF A01.

In this report capabilities and services are described for the Atmospheric Release Advisory Capability (ARAC). The ARAC site system and its operating procedures and interactions with the ARAC central facility located at LLL is outlined. ARAC is designed to help officials at designated ERDA sites and other locations in estimating the effects of atmospheric releases of radionuclides or other hazardous materials by issuing real-time advisories to guide them in their planning.

57369 **External environmental radiation levels from natural sources.** Beck, H.L. (Energy Research and Development Administration, New York). *Trans. Am. Nucl. Soc.;* **26**: 117-118(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57370 **Radiation levels in the vicinity of ERDA facilities.** Burson, Z.G. (EG and G Idaho, Inc., Idaho Falls, ID); Elle, D.R. *Trans. Am. Nucl. Soc.;* **26**: 119-120(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57371 **Use of sulfur hexafluoride tracer techniques for near-stack dispersion studies.** Rubin, M.P.; Kastenberg, W.E. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **26**: 122-123(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57372 **AEOLUS: atmospheric dispersion and finite-cloud doses during normal, sea-breeze, and accident conditions.** Hamawi, J.N.; Laznow, J. (Yankee Atomic Electric Co., Westboro, MA). *Trans. Am. Nucl. Soc.;* **26**: 123(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57373 **Probabilistic prediction of X/Q for routine intermittent gaseous releases.** Potter, T.; Woodard, K.; Kaplan, S. (Pickard, Lowe, and Garrick, Inc., Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 123-124(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57374 (MLM—2441(TR)) **Sensitive method for continuous air monitoring for ^{14}C and ^{3}H.** Rudolph, J.; Weiss, W. Translated from *Atomwirtsch., Atomtech.;* **21**: No. 9/10, 485-488(1976). 16p. Dep. NTIS, PC A02/MF A01.

In the monitoring of air for ^{14}C and ^{3}H the necessary sensitivity cannot be achieved by direct measurement, but only through continuous sampling and scintillation spectroscopy. The two radionuclides are separated from each other at the time of sampling. In addition, by a catalytic reaction over CuO at 600°C, a differentiation is achieved between tritiated atmospheric water vapor (HTO), $^{14}CO_2$ and other isotopically labeled substances contained in the air. Tritium is obtained in the form of water and ^{14}C as $Na_2{}^{14}CO_3$. Radioactivity is measured in a scintillation spectrometer. For tritium this method has a detection limit of 0.8 pCi/m^3 or air, and for C^{14} 0.6 pCi/m^3 of air. These values correspond to 15 to 30% of the mean background concentration for HTO and $^{14}CO_2$ observed up to the present.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 56345, 56752, 57362, 57363

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 56930

REGULATIONS

REFER ALSO TO CITATION(S) 57352

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

REFER ALSO TO CITATION(S) 57351, 57366

57375 (ARH-SA—278) **Calculated and observed nonisothermal multiphase in flow in vertical columns.** Nelson, R.W.; Easley, P.G. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 1976. Contract EY-76-C-06-2130. 16p. (CONF-761229—2). Dep. NTIS, PC A02/MF A01.

From Fall meeting of the American Geophysical Union; San Francisco, California, United States of America (USA) (6 Dec 1976).

A mathematical formulation which describes the movement of air, water vapor, and liquid water in dry desert soils is presented. The equations are a combination of those used in the oil industry for nonisothermal-multiphase flow and those from the soil science literature which includes the effects of vapor diffusion in a static air phase. The equations can be solved numerically by using either finite differences or collocation on finite elements for long, one-dimensional vertical flow systems under very low moisture conditions.

57376 (CONF-770228—1) **Current perceptions and applicability of ecosystem analysis to impact assessment.** Auerbach, S.I. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 38p. Dep. NTIS, PC A03/MF A01.

From Symposium on stress effects on natural ecosystems; Columbus, Ohio, United States of America (USA) (4 Feb 1977).

The concept of cost-benefit analysis in relation to the assessment of various factors causing stress on natural ecosystems is discussed. It is pointed out that if stress is considered in the context of a deviation from some homeostatic condition, we do face a number of technical and socially related questions. The technical questions are those concerning the need to define in rigorous scientific terms the meaning of ecosystem homeostasis. What is the significance, both temporally and spatially, of a deviation from such homeostasis, and of the elucidation in quantitative terms of the acceptability and nonacceptability of such a deviation. The latter, of course, puts us into our role as scientist-citizens. There we enter the realm of value judgment where we provide only one of many inputs which need to be considered by an institutional decision-maker.

57377 **Mineral element composition of the natural vegetation along a transect at Mareotis, Egypt.** El-Ghonemy, A.A.; El-Gazzar, A.M.; Wallace, A.; Romney, E.M. (Univ. of Alexandria, Egypt). *Soil Sci.;* **124**: No. 1, 16-26(Jul 1977).

A detailed investigation has been carried out to determine, through tissue analysis, the nutritional status of 55 plant species of the Egyptian wild flora collected from the desert area of Burg El-Arab, west of Alexandria. The data obtained resulted in classifying the different species into 17 groups, each being specifically rich in a given element. The relationship between the level of elements and the kind of habitats has also been discussed.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 57204, 57366, 57390

57378 (COO—2727-5) **Contamination of groundwater by heavy metals from the land disposal of fly ash. Technical progress report, September 1, 1976—May 31, 1977.** Theis, T.L. (Notre Dame Univ., Ind. (USA). Dept. of Civil Engineering). Jun 1977. Contract EY-76-S-02-2727. 34p. Dep. NTIS, PC A03/MF A01.

Field studies were conducted at the fly ash disposal site of a 735 MW coal-fired power plant. Disposal consisted of ponding the ash followed by eventual removal and ultimate deposition as fill. Several sampling wells were made in order to monitor the groundwater quality. Trace metals analyzed include As, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Se, and Zn. Results indicated that trace metals are released to the groundwater from the pond at generally low levels. Increased concentrations several times the normal levels were observed when the pond first began the filling cycle and again when maintenance procedures brought about a large fly ash loading in a short time. Metals were found to accumulate in soils at the point of confluence of the pond seepage water with the natural groundwater which was high in dissolved carbonate. Deposition as carbonates and adsorption of metals onto the higher levels of hydrous iron and manganese oxides were considered responsible for this. Effective control strategies, if deemed necessary, would include pH adjustment of pond water with lime or limestone, lining of ponds with natural or chemical materials, and relocation to a more environmentally suitable site.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 56588, 57367, 57397

57379 (BNWL-SA—5975(Rev.)) **Ratio estimation techniques in the analysis of environmental radionuclide data.** Doctor, P.G.; Gilbert, R.O. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1977. Contract EY-76-C-06-1830. 20p. (CONF-761065—8). Dep. NTIS, PC A02/MF A01.

From Symposium on dynamics of transuranics in terrestrial and aquatic environments; Gatlinburg, Tennessee, United States of America (USA) (5 Oct 1976).

Ratios play a prominent role in the analysis of environmental transuranic data. The mathematical assumptions underlying the use of ratios are presented. The properties of seven different estimators of an average ratio and their standard errors are discussed with respect to their applicability to transuranic field studies. The behavior of these estimators, their standard errors, and confidence intervals are compared for three representative sets of data from safety-shot sites at the Nevada Test Site and Tonapah Test Range. Guidelines are given for deciding if an average ratio is appropriate. Recommendations for avoiding an inappropriate estimator are discussed.

57380 (CONF-770647—1) **Effects of substrate type and arsenic dosage level on arsenic behavior in grassland microcosms. Part I. Preliminary results on ^{74}As transport.** Draggan, S. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

From Symposium on terrestrial microcosms and environmental chemistry; Corvallis, Oregon, United States of America (USA) (13 Jun 1977).

Microcosm design is an important factor in interpreting results obtained from studies of the environmental effects, mobility and persistence of contaminants. The behavior of pentavalent arsenic and a radioarsenic tracer was studied in three substrate types exposed to differing levels of stable As dosage. Soil cores excised intact from a natural grassland ecosystem were considered to most reliably represent the natural system under study since they retained the soil structure, and closely simulated the abiotic and biotic complexity, of the grassland ecosystem. The behavior of ^{74}As in the components of intact soil core microcosms differed appreciably from that observed for the other microcosm types where soil underwent manipulation. These differences were explained primarily on the basis of differences in soil structure.

57381 (CONF-770676—1) **Concentrations of radionuclides and selected stable elements in fruits and vegetables.** Oakes, T.W.; Shank, K.E. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

From 11. annual conference on trace substances in environmental health; Columbia, Missouri, USA (7 Jun 1977).

Twenty-two types of fruits and vegetables collected from two commercial supermarkets have been analyzed for their radionuclidic and stable-element composition. A specific gamma-emitting isotope analysis was performed on each sample for ^{40}K, ^{60}Co, ^{95}Zr-Nb, ^{106}Ru, ^{137}Cs, ^{226}Ra, and ^{232}Th. The concentration of the stable elements in each sample were determined using multi-element neutron-activation analysis (Al, Ag, Au, As, Ba, Br, Ca, Ce, Cl, Co, Cr, Cs, Cu, Eu, Fe, Hf, I, K, La, Mn, Mo, Mg, Na, Rb, Sb, Sc, Se, Sr, Ta, Te, Th, Tl, Zn, Zr) and atomic absorption (Cd, Ni, Pb). Information on the composition of a typical diet is used to estimate the radiological dose to man subsequent to ingestion of these fruits and vegetables. The stable-elemental compositions of the foodstuffs analyzed were compared with estimated values assuming foliar deposition and long-term buildup of effluents from a large modern coal-fired steam plant. It is tentatively concluded that for the general case of a precipitator-equipped, coal-fired steam plant, no toxic levels of trace elements in foodstuffs are expected as a result of the plant operation.

57382 (DP-MS—76-89) **Assessment of potential radiation dose-to-man from an acute tritium release into a forest ecosystem.** Watts, J.R.; Murphy, C.E. Jr. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1977. Contract EY-76-C-09-001. 14p. (CONF-770720—3). Dep. NTIS, PC A02/MF A01.

From 22. annual meeting of the Health Physics Society; Atlanta, Georgia, USA (3 Jul 1977).

On May 2, 1974, 479,000 curies of tritium gas escaped from a Savannah River Plant exhaust stack. The tritium first reached the ground in a pine forested area and was partially assimilated into the ecosystem. Samples of vegetation collected and measured for a period of 70 days showed an increase in the levels of tritiated water. Cycling of the tritium retained in the forest ecosystem resulted in a higher concentration of tritiated water vapor in the air at breathing height near the forest floor than that calculated by the usual models used for predicting air concentration. In addition, the model for tritium cycling in the forest predicts a diurnal cycle of tritiated water vapor concentration with higher concentrations at night when air movement under the canopy is slower. The potential dose to the maximum individual because of inhalation and skin absorption of tritium as HTO after the release was calculated three ways: by using the body water model from the International Commission on Radiological Protection (ICRP) Publication 2 and assimilation during the passage of the puff; by using the body water model from the ICRP Publication 2 and assimilation during an extended exposure period to tritium determined by the experimental measurements; and by using a three-compartment dosimetry model with retention half times of 9, 30, and 450 days with the extended exposure period. The potential doses were 0.14, 0.80, and 0.89 mrem, respectively. These potential doses show the necessity of considering the interaction of radioactive material with the ecosystem for dose calculation.

57383 (NVO—1253-11) **Constitutive relations for flow of water in the unsaturated zone.** Case, C.M. (Nevada Univ., Reno (USA). Desert Research Inst.). Jun 1977. Contract EY-76-C-08-1253. 22p. Dep. NTIS, PC A02/MF A01.

The study of flow of water and the concomitant transport of radionuclides in the unsaturated zones of the Nevada test site has necessitated a detailed and thorough review of fundamental unsaturated flow theory. In the course of this review it became evident that additional formalism to describe the basic quantities and state the fundamental concepts of unsaturated flow was required. This report introduces the terminology and concepts of a more precisely formulated theory (mostly scaler at this stage) of unsaturated flow than has appeared in the literature up to this time. The results given here are basic and add to the precision of the formulation of the equations for flow in the unsaturated zone.

57384 (UCRL—79214(Rev.1)) **Material control assessment procedure.** Adams, R.W.; Spogen, L.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1977. Contract W-7405-ENG-48. 10p. (CONF-770656—4). Dep. NTIS, PC A02/MF A01.

From Annual meeting of the Institute of Nuclear Materials Management; Washington, District of Columbia, United States of America (USA) (29 Jun 1977).

The material control system assessment procedure being developed by the Lawrence Livermore Laboratory for the U.S. Nuclear Regulatory Commission is reviewed. It consists of five major sections: Target Identification, Adversary Sequence and Simuli Generation, Material Control System Response Determination, Safeguard System Outcome Determination, and Safeguard System Utility Determination. When adopted, this procedure will reduce safeguards licensing problems by providing compatibility with future performance based regulations, explicit evaluation rules and requirements, well-defined trade-off structures, and user-oriented and systematic evaluation and design tools.

57385 **ERDA's National Aerial Radiometric and Magnetic Survey.** Dodd, P.H. (Energy Research and Development Administration, Grand Junction, CO). *Trans. Am. Nucl. Soc.;* **26**: 118-119(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

SOIL

REFER ALSO TO CITATION(S) 56196, 56750

THERMAL EFFLUENTS MONITORING AND TRANSPORT

57386 Analysis of buoyant surface jets. Shirazi, M.A. (Corvallis Environmental Research Lab., OR); Davis, L.R. *J. Heat Transfer;* **98**: No. 3, 367-372(Aug 1976).

To obtain improved prediction of heated plume characteristics from a surface jet, an integral analysis computer model was modified and a comprehensive set of field and laboratory data available from the literature was gathered, analyzed, and correlated for estimating the magnitude of certain coefficients that are normally introduced in these analyses to achieve closure. The parameters so estimated include the coefficients for entrainment, turbulent exchange, drag, and shear. Since there appeared considerable scatter in the data, even after appropriate subgrouping to narrow the influence of various flow conditions on the data, only statistical procedures could be applied to find the best fit. This and other analyses of its type have been widely used in industry and government for the prediction of thermal plumes from steam power plants. Although the present model has many shortcomings, a recent independent and exhaustive assessment of such predictions revealed that in comparison with other analyses of its type the present analysis predicts the field situations more successfully.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 55671, 56915, 56930, 56986, 57379, 57383

57387 (BNWL-SA—6089) **Land rehabilitation research at Pacific Northwest Laboratories.** Rickard, W.H.; Sauer, R.H. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1977. Contract EY-76-C-06-1830. 21p. Dep. NTIS, PC A02/MF A01.

One of the major goals of rehabilitation of surface mined lands is to establish a self-sustaining vegetative cover. The cover should provide protection against wind and water erosion and provide forage for wildlife and livestock comparable to that of premining conditions. Although livestock grazing has been practiced in the Western United States for more than a century there is a general paucity of information concerning the primary productivity of western rangelands. The productivity of sagebrush-bluebunch wheatgrass ecosystems was studied at the U. S. ERDA Hanford Reservation in South Central Washington. Here a stand of sagebrush-bluebunch wheatgrass vegetation was quantitatively sampled for four consecutive years, and results are reported from a controlled cattle grazing study to determine the ability of sagebrush-bluebunch wheatgrass communities to sustain moderate grazing pressure, and to measure weight gains of cattle. The effects of severe soil disturbances caused by plowing on native plant communities were also studied. The purpose of the restoration of surface mined lands conducted on the arid Hanford Reservation is to use modern machinery such as that used in removing the overburden from coal seams to create an environment that is more favorable to plant growth than conventional land leveling and topsoiling. The project consists of two parts: modifying the topography to accumulate precipitation (water harvest), and the placement of topsoil in sufficient depth to provide soil water storage and mineral nutrition to enable the growth of plants with greater productivity and higher economic value than those plants that can be cultivated under conventional land restoration practices.

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 56922, 57047, 57376

57388 (CONF-770552—1) **Chloro-organics in surface water sources for potable water.** Jolley, R.L.; Pitt, W.W. Jr. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 12p. Dep. NTIS, PC A02/MF A01.

From 97. annual conference of the American Water Works Association; Anaheim, California, United States of America (USA) (8 May 1977).

Since those complex biochemical reactions that we call life processes require an aqueous medium, a safe and adequate drinking water supply must be considered a prime requisite for human life. Therefore, clean water, or water without life-interfering contaminants, is a basic necessity for survival of the human race. Modern water treatment technology has been proven capable of supplying potable waters, free from pathogenic organisms, from a variety of sources including surface waters. However, surface waters may contain a variety of organic constituents, including chloro-organic compounds that have been contributed by industrial effluents, cooling water effluents from electric power-generating plants, agricultural and urban runoff, and effluents from sewage treatment plants. These organic compounds and the increasing development of new industrial products represent a continuing challenge to water treatment scientists and engineers to ensure safe and sufficient potable water supplies for the future. This is particularly true because relatively little information is now available concerning identities and concentrations of these chloro-organic compounds and their transport, distribution, and degradation in surface water systems. This paper surveys the literature with respect to the presence and formation of chloro-organics in natural waters. It is not a critical analysis of the literature surveyed, nor does it attempt to completely cover the voluminous amount of pesticide literature.

57389 (COO—1599-120) **Adenosine triphosphate concentration in relation to microbial biomass in aquatic systems.** Cunningham, H.W. Jr. (Michigan State Univ., East Lansing (USA). Dept. of Botany and Plant Pathology). 1977. Contract EY-76-S-02-1599. 49p. Dep. NTIS, PC A03/MF A01.

Analyses of adenosine triphosphate (ATP) extracted from a sediment community by the sulfuric acid method are complicated by inhibitions from inorganic and organic compounds. Inhibitions by inorganic compounds are reversible while those by organic compounds are irreversible. The primary inhibition by organic compounds results by complexing with acid-soluble fulvic acids which will prevent the detection of as much as 80% of the ATP present in a sample by the luciferin-luciferase reaction. Analytical techniques were developed to parially circumvent such interferences. Biomass interpretations from ATP concentrations in aquatic systems are complicated by the diversity of the microbiota and by the variability in the carbon to ATP ratio caused by environmental conditions. However, when levels of ATP are considered as a physiological condition of a sedimentary community, this data provide a means to interpret community metabolism not available hitherto.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 55653, 56753, 57207, 57353, 57366, 57401

57390 (BNL—50600) **Data report: Marsh/Pond system.** Small, M.M. (Brookhaven National Lab., Upton, N.Y. (USA)). Nov 1976. Contract EY-76-C-02-0016. 28p. Dep. NTIS, PC A03/MF A01.

The Marsh/Pond system is one of several experimental facilities that were constructed at Brookhaven National Laboratory in 1973. Since April 1975, these facilities have been used as prototypes for the purpose of developing natural systems to continuously renovate sewage to groundwater rechargeable quality. These systems, as semi-works, continue to be operated in developing modes for this purpose. The Marsh/Pond system appeared to offer the most promise in meeting the recharge objective after one year's operation in a continuous mode. Because of interest shown in these systems, it was decided to publish the data obtained from this first year of operation of the Marsh/Pond semi-works. Since this system is still under study, it is believed premature to draw detailed conclusions from these first year data beyond the observation that a Marsh/Pond will convert weak sewage into water which is suitable for recharge through a vegetated sandy loam. This publication of these data is intended to demonstrate that observation. A supplemental report will be published after the second year of operation of this system. A data report on the first year's operation of the Meadow/Marsh/Pond system is in preparation and also will be supplemented after two years of observation.

57391 (COO—3292-28) **Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976—30 June 1977.** Gross, M.G.; Eaton, A.D.; Grant, V. (Johns Hopkins Univ., Baltimore, Md. (USA). Chesapeake Bay Inst.). 1977. Contract EY-76-S-02-3292. 69p. Dep. NTIS, PC A04/MF A01.

Progress is reported on studies on the geochemistry and fate of trace amounts of Fe, Mn, Cu, and Zn in surface waters and sediments of the Susquehanna River and Chesapeake Bay. The path of suspended sediments in Chesapeake Bay and San Francisco Bay were compared.

57392 (NIRS-M—10, pp 1-7) **Mixing process of pollutants in coastal waters.** Wada, A. (Central Research Inst. of Electric Power Industry, Tokyo, (Japan)). Oct 1975. (In Japanese).

From 2. National Institute of Radiological Sciences seminar; Chiba, Japan (28 Feb 1975).

In Fundamental aspects of marine radioecology. I.

A comprehensive description is given of the physical factors involved in the dispersal of pollutant in the sea, based mainly on observational data obtained in the sea around Japan. From the view point of time and space scales, parameters in small-scale diffusion are current velocity U sub(i) and diffusivity in the horizontal K sub(h) and in the vertical K sub(z). K sub(h) and Ksub(z) depend on turbulence intensity. Horizontal dispersion may be accelerated by current shear. On a larger scale, the meandering of effluent plumes becomes an important dispersal mechanism. Currents in inland sea and bay have outstanding periodical back-and-forth current, so we put this current into the analysis as the time function to predict the diffusion of pollutant. In the sea where we can see the current as above mentioned, mainly the meso scale eddies like tidal current predominate the diffusion distribution. Therefore, it is necessary to make a full grasp of the tidal component including the steady current component. However, in the open sea region where we can not see the periodical current, random current is predominant and the diffusion situation shows the complicated distribution. Accordingly the prediction method of diffusion at the point as this must be conducted treating random current as a sort of large group of eddies except the steady current and representing this action in a form of diffusion coefficient to make analysis. The diffusion coefficient should be defined in reference with statistic treatment of continuous observation results for a long time about the flow. Therefore, when we want to acquire the diffusion distribution of pollutant, the fluctuations of natural phenomena must be put into consideration.

57393 (PB—264 936) **Water pollution caused by inactive ore and mineral mines - a national assessment. Final report.** Martin, H.W.; Mills, W.R. Jr. (Toups Corp., Santa Ana, Calif. (USA)). Dec 1976. Contract EPA-68-03-2212. 198p. NTIS PC A09/MF A01.

The report identifies the scope and magnitude of water pollution from inactive ore and mineral mines. Data collected from Federal, State, and local agencies indicates water pollution from acids, heavy metals, and sedimentation occurs at over 100 locations and affects over 1200 kilometres of streams and rivers. The metal mining industry was shown to be the principal source of this pollution. Descriptions of the mineral industry are presented, including a summary of economic geology, production methods, and historic mineral production methods, and historic mineral production. The mechanisms of formation, transportation, and removals of pollutants are detailed. Annual pollutant loading rates for acid and metals from inactive mines are given and a method provided to determine the extent of mine-related sedimentation in Western watersheds. State-by-state summaries of mine related pollution are presented. An assessment of current water pollution abatement procedures used for inactive mines is given and research and development programs for necessary improvements are recommended.

57394 (PB—265390) **Connecticut river water resource decision-making. Completion report.** Kaynor, E.R. (Massachusetts Univ., Amherst (USA). Water Resources Research Center). Jul 1976. Contract DI-14-31-0001-9058. 405p. NTIS PC A18/MF A01.

Development of resource projects and programs in the Connecticut River basin are traced from Colonial times to the present. Case materials on five areas of modern concern are emphasized. They are water supply (including out-of-basin diversion), water pollution control, flood control, electric power generation, and recreational/preservational programs. Methods employed include historical reconstruction through written documents, interview of participants in current resource planning programs, participant observation, and an experimental attempt to simulate a decision-making situation. Theoretical focus is on how decisions to undertake basin resource programs evolved and on what bearing prior resource actions have on decisional options. A major conclusion is that incremental planning strategies have produced more satisfactory outcomes than comprehensive planning strategies, but that planning theory suffers from its conceptual disassociation of rational-deductive methodology and incremental strategy.

57395 **Power plant impact on chemical quality of surface and groundwaters.** Samworth, R.B. (Nuclear Regulatory Commission, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 106(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57396 **Fishing for toxicity: biological automonitor for continuous water quality control.** Morgan, W.S.G. *Effluent Water Treat. J.;* **16**: No. 9, 471-475(Sep 1976).

A rapid biological automonitoring system, intended to complement physical-chemical monitoring techniques, has been developed which utilizes the increase in fish opercular rythms under toxic conditions. Any increase which is above the rate to be expected under normal conditions, is monitored electronically. A built-in visual alarm system serves as an advance warning of an impending harmful condition. The system can also be used to control toxic industrial discharges, thus aiding the preservation of the quality of receiving waters.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 57353, 57367

57397 (ARH-SA—292) **Hanford groundwater scenario studies.** Arnett, R.C.; Gephart, R.E.; Deju, R.A.; Cole, C.R.; Ahlstrom, S.W. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). May 1977. Contract EY-76-C-06-2130. 52p. Dep. NTIS, PC A04/MF A01.

This report documents the results of two Hanford groundwater scenario studies. The first study examines the hydrologic impact of increased groundwater recharge resulting from agricultural development in the Cold Creek Valley located west of the Hanford Reservation. The second study involves recovering liquid radioactive waste which has leaked into the groundwater flow system from a hypothetical buried tank containing high-level radioactive waste. The predictive and control capacity of the onsite Hanford modeling technology is used to evaluate both scenarios. The results of the first study indicate that Cold Creek Valley irrigationis unlikely to cause significant changes in the water table underlying the high-level waste areas or in the movement of radionuclides already in the groundwater. The hypothetical tank leak study showed that an active response (in this case waste recovery) can be modeled and is a possible alternative to passive monitoring of radionuclide movement in the unlikely event that high-level waste is introduced into the groundwater.

57398 (BNWL—2227) **Finite element models for sediment and contaminant transport in surface waters. Transport of sediments and radionuclides in the Clinch River.** Onishi, Y. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jul 1977. Contract EY-76-C-06-1830. 116p. Dep. NTIS, PC A06/MF A01.

Radionuclide migration in rivers was simulated in this study to advance the state-of-the-art of computer modeling on radionuclide transport by including the effects of sediment-radionuclide interaction. Specifically, the finite element sediment and contaminant transport model, SERATRA, was modified and applied to the Clinch River in Tennessee to solve time-dependent, longitudinal and vertical distributions of sediments and radionuclides. Sediment transport was modeled for each sediment size fraction (i.e., sand, silt and clay), and radionuclide transport was modeled for dissolved and particulate nuclides. Furthermore, particulate radionuclides were solved for those adsorbed by each sediment size fraction. Three radionuclides, cesium-137, strontium-90 and gold-198, were selected as sources of continuous and instantaneous releases because of their adsorption characteristics and field data availability. Agreement of predicted results and field data for continuous release cases was very good, while for instantaneous releases agreement was poor. It was revealed that approximately 93 percent of the cesium-137 is in a particulate form, and only about 7 percent is dissolved. The model predicted that approximately 50 percent of the cesium 137 introduced in the Clinch River will be deposited on the river bed before it reaches the river mouth as a result of contaminated sediment deposition in slow moving areas of the river. Results on strontium-90 indicated the opposite trend, i.e., approximately 97 percent is in the dissolved form and only 3 percent was associated with the sediment; hence, the majority of strontium-90 moves with the water through the river system. Gold-198 was used for instantaneous release simulation, but since agreement between simulated results and data was not good no conclusions can be drawn for this case.

57399 (RLO—2231-T1-9) **Vertical distribution of ^{55}Fe in the ocean.** Jennings, C.D. (Oregon Coll. of Education, Monmouth (USA)). 1976. Contract EY-76-S-06-2231-001. 3p. (CONF-7610109—1). Dep. NTIS, PC A02/MF A01.

From 25. congress and plenary assembly of CIESM; Split, Yugoslavia (22 Oct 1976).

The highest concentrations of ^{55}Fe in the ocean are found in the epipelagic and mesopelagic zones with only low concentrations occurring in benthic animals and sediments. ^{55}Fe in the sediment appears in a very thin surface layer in the equatorial Pacific so that great care in sampling must be exercised to ensure accurate measurement.

WATER

REFER ALSO TO CITATION(S) 55927

AQUATIC ECOSYSTEMS AND FOOD CHAINS

57400 (NIRS-M—10) **Fundamental aspects of marine radioecology. 1.** (National Inst. of Radiological Sciences, Chiba (Japan)). 1975. vp. (CONF-750269—). Dep. NTIS (US Sales Only), PC A03/MF A01.

From 2. National Institute of Radiological Sciences seminar; Chiba, Japan (28 Feb 1975).

Separate abstracts were prepared for individual papers. (ERB)

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 56239, 57386

57401 (EPRI-SR—38(Vol.1)) **Report of a workshop on the impact of thermal power plant cooling systems on aquatic environments, Asilomar, Pacific Grove, California, September 28—October 2, 1975. Volume I. Working group results.** (Sigma Research, Inc. Richland, Wash. (USA)). Apr 1976. 127p. Dep. NTIS, PC A07/MF A01.

The following topics were considered at the workshop: collection and compilation of information relevant to effects of thermal power plant cooling systems and development of an information center; ecological characterization of power plant cooling systems and cooling water bodies; biological factors related to entrapment; impingement, entrainment and the resulting mortality and damage to individual organisms; identification and measurement of reactions by individual organisms to chemical effluents under field conditions; accuracy and precision of various chlorine monitoring systems; and ecosystem management. (HLW)

57402 (PB—265346) **Indiana stream-temperature characteristics. Water-resources investigations (final).** Shampine, W.J. (Geological Survey, Indianapolis, Ind. (USA). Water Resources Div.; Indiana State Board of Health, Indianapolis (USA); Indiana State Dept. of Natural Resources, Indianapolis (USA). Div. of Water). Mar 1977. 62p. (USGS/WRI—77-6; USGS/WRD/WRI—77/020). NTIS PC A04/MF A01.

Prepared in cooperation with Indiana State Board of Health, Indianapolis, and Indiana State Dept. of Natural Resources, Indianapolis. Div. of Water.

Periodic stream-temperature data collected at 280 different sites in Indiana by the U.S. Geological Survey and the Indiana State Board of Health were analyzed by a simple harmonic-curve-fitting procedure. Calculated harmonic coefficients were related to 23 topographic, basin, and climatic characteristics, and were analyzed by multiple-regression analysis techniques. The regional regression analysis for the harmonic-mean stream temperature, M, resulted in the following arithmetic function of station latitude (LAT): M = 41.36 - 0.7166 (LAT). The mean temperature of the White River at Indianapolis was raised 3.5C above expected ambient levels caused by climatic conditions alone, primarily as a result of discharges from powerplants. (Color illustrations reproduced in black and white.)

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 55606, 56986, 57395

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 55607, 55655, 55851, 56747, 56915, 56919, 56946, 56947, 56959, 56984

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 56598, 56930

57403 (EPRI-EA—405-SR) **Proceedings of a workshop on the measure of intangible environmental impacts.** (Sigma Research, Inc. Richland, Wash. (USA)). Mar 1977. 152p. (CONF-7608101—). Dep. NTIS, PC A08/MF A01.

From Workshop on the measure of intangible environmental impacts; Pacific Grove, California, United States of America (USA) (3 Aug 1976).

The report summarizes the output of a workshop on the measurement of intangible environmental impacts associated with energy development and generation. Methodological experience gained from past and existing studies on the workshop topic is summarized. The methodological approaches considered were the hedonic approach, decision analysis approaches, approaches based on observations of individual behavior, bidding game and asking approaches, and approaches which combine social and technical factors. Existing research gaps are identified and suggestions are offered for future research programs which treat "intangible" environmental impacts.

57404 **Health hazards of alternative electricity generation fuel cycles.** Hamilton, L.D. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 134(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57405 **Ultimate trade-off problem: comparative social impacts of electrical energy alternatives.** Peelle, E. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 135(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 56344, 56357

BIOMEDICAL SCIENCES, BASIC STUDIES

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 57389

57406 (CALT—767P6-X12) **Studies in developmental immunogenetics. Annual progress report.** Owen, R.D. (California Inst. of Tech., Pasadena (USA). Div. of Biology). 29 Jun 1977. Contract EY-76-S-03-0767-006. 6p. Dep. NTIS, PC A02/MF A01.

This contract provides the research support for a group concerned with a relatively large range of problems. The integrating thread that runs through it is that of an interest in development and its genetic regulation, mainly in complex organisms and with an emphasis on the immune system as a model for developmental analysis and as a tool for following the development of other systems, especially the brain. It includes studies of biochemical genetics, primarily from a developmental viewpoint and with particular regard to defense mechanisms, and cellular aspects of the immune system. It extends into the area of cancer immunology and cell specificities as related to tumor systems and to disruptions of genetic control mechanisms in tumor development, especially as approached through the reappearance of fetal antigens associated with tumor development. During the past year, our attention has turned increasingly to genetic factors predisposing to autoimmune disease, and to factors that have been claimed to transfer specific cellular immunity from immune to nonimmune animals.

57407 (CONF-761234—3) **Argonne Bioanalytical Center: a resource for collaborative biomedical applications of stable isotopes.** Klein, P.D.; Szczepanik, P.A.; Hachey, D.L.; Schoeller, D.A. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 15p. Dep. NTIS, PC A02/MF A01.

From International symposium on biological application of stable isotopes; Leipzig, German, Federal Republic of (F.R. Germany) (6 Dec 1976).

The Argonne Bioanalytical Center was instituted in 1970 to promote the application of stable, non-radioactive isotopes to clinical research diagnosis. The Center has maintained a program of explorative syntheses, designed to provide the required compound labeled with ^{2}H, ^{13}C, or ^{15}N; a program of instrumental development, with the objective of constructing prototype instruments for determining isotope ratios in organic molecules using gas chromatography-mass spectrometry; a program of analytical development that permits isolation of key labeled molecules from the clinical sample in preparation for isotope ratio measurements; and finally, an extended network of clinical collaborators who are concerned with the pharmacological, pediatric, gynecological, and gastroenterological applications of stable isotopes. In addition, the Center, under the sponsorship of Argonne National Laboratory has convened meetings on these applications of stable isotopes which were held in 1971, 1973, and 1975. The proceedings from each meeting have been published and comprise, in total, about 160 papers by workers in the United States, Europe, and Asia.

57408 (CONF-770346—1) **Influence of Hg^{2+} on the excited states of DNA: photochemical consequences.** Rahn, R.O. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 7p. Dep. NTIS, PC A02/MF A01.

From Symposium on excited states in organic and biochemistry; Jerusalem, Israel (28 Mar 1977).

Bound Hg^{2+} quenches thymine dimerization and thymine phosphorescence in DNA only when bases other than thymine are mercurated. Triplet sensitization studies show that this quenching can occur at the triplet level. However, room temperature fluorescence studies indicate that only a fraction of the short-lived (approximately 10^{-12} sec) thymine singlet state is quenched by Hg^{2+} enhanced intersystem crossing. Hence, at room temperature the most likely mechanism for quenching of photodimerization in DNA involves energy trapping at the singlet level by a neighboring mercurated base, presumably adenine which has the largest red shift in its absorbance upon complexing with Hg^{2+}. At 77 K, on the other hand, Hg^{2+} can completely quench the fluorescence of all the bases because of the longer singlet lifetimes. Consequently the quenching of the thymine phosphorescence occurs via triplet transfer, a result substantiated by acetophenone sensitization studies at room temperature.

57409 (CONF-770555—1) **Double-helical regions in Kilham rat virus DNA.** Lavelle, G.; Mitra, S. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 22p. Dep. NTIS, PC A02/MF A01.

From Cold Spring Harbor symposium; Cold Spring Harbor, New York, United States of America (USA) (12 May 1977).

The secondary structure of intact KRV DNA is characterized by hydroxyapatite chromatography and by reaction with single- and double-strand-specific DNAases. The isolation of two double-helical DNA fragments of viral DNA is described and evidence is presented that the larger fragment is located at the 3′ end of the viral genome. The single-stranded genome of KRV has a stable and characteristic secondary structure as evidenced by retention on hydroxyapatite high thermal stability, and resistance to single-strand-specific exonuclease I. (HLW)

57410 (CONF-770555—2) **DNA replication of the parvovirus Kilham rat virus. I. Characterization of intracellular forms of viral DNA extracted by guanidine hydrochloride.** Li, A.T.; Lavelle, G.; Tennant, R.W. (Tennessee Univ., Oak Ridge (USA). School of Biomedical Sciences; Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

From Cold Spring Harbor symposium; Cold Spring Harbor, New York, United States of America (USA) (12 May 1977).

The following experimental procedures are described: infection of rat kidney cell cultures with Kilham rat virus (KRV); labeling and extraction of DNA; sucrose density gradient sedimentation; digestion by S_1 nuclease; and chromatography of DNA on benzoylated-napthoylated DEAE(BND)-cellulose columns. Results are discussed with regard to isolation and purification of intracellular forms of KRV DNA; velocity sedimentation in alkaline sucrose gradients; S_1 nuclease digestion of intracellular viral DNA; BND-cellulose chromatography; and pulse-chase experiment for identification of RIs. Results indicate that within the infected cell and at a time of active viral DNA replication, three populations of viral-specific molecules can be obtained by extraction with guanidine HCl. Characteristics of the three populations are described. (HLW)

57411 (CONF-770648—1) **Conformational states of chromatin.** Zama, M.; Bryan, P.N.; Harrington, R.E.; Olins, A.L.; Olins, D.E. (Tennessee Univ., Memphis (USA). Dept. of Physiology and Biophysics; Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 40p. Dep. NTIS, PC A03/MF A01.

From Cold Spring Harbor symposium on quantitative biology; Cold Spring Harbor, New York, United States of America (USA) (1 Jun 1977).

The concept of a repeating subunit within eukaryotic chromatin structure, the ν body or nucleosome, is now widely accepted. Recent biochemical studies have indicated the possibility that the ν body persists in an altered conformation in presumed transcriptionally-active chromatin. We have, therefore, initiated an investigation of the conformational states of isolated ν bodies and chromatin induced by ineractions with chemical perturbants. The present study describes two aspects of such conformational studies. In the first part we compare the destabilizing effects of urea on ν bodies, chromatin and stripped chromatin (i.e., chicken erythrocyte chromatin depleated of H5 and H1) employing a number of biophysical criteria. An extensive study of the effects of urea (0-10 M) on ν body core particles (ν_1) has been previously reported. The second part of this paper describes the reassociation of ν_1 containing a site-specific extrinsic fluorescent probe, capable of rapid and sensitive "reporting" of induced conformational transitions.

57412 (CONF-770648—2) **ν bodies are close-packed in chromatin fibers.** Olins, A.L. (Tennessee Univ., Memphis (USA). Dept. of Physiology and Biophysics; Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

From Cold Spring Harbor symposium on quantitative biology; Cold Spring Harbor, New York, United States of America (USA) (1 Jun 1977).

Chromatin fibers 20-30 nm in diameter have been observed in thin sections and in chromatin spreads. More recently two different models for the substructure of these chromatin fibers have been proposed. The solenoid model postulates that a 10-nm rigid rod of uniform electron density, the "nucleofilament," of Sperling and Tardieu, is wound into a helical structure, 30-50 nm in diameter with a central hole approximately 10 nm in diameter. A solenoid was visualized earlier in the electron micrographs of Filip et al. The model of close-packed ν bodies (nucleosomes) has been suggested by Carlson and Olins (1976), Carpenter et al. (1976), and Olins (1977). In this model the particles maintain their individuality despite the tight arrays observed in solutions with higher salt concentrations. The periodicity of histones (octamers) and DNA (nuclease labile sites interspersed with 140 base-pair-protected segments) is preserved in the 20- to 30-nm fiber. The purpose of this communication is to present electron microscopic evidence that the ν body persists at this level of the chromatin structural hierarchy.

57413 (ORO—3628-11) **Mechanisms of innate immunity: cytoplasmic granules of polymorphonuclear neutrophilic granulocytes, antimicrobial action, translocation, role, and fate in antimicrobial phagocytosis. Progress report, March 1976—June 30, 1977.** Spitznagel, J.K. (North Carolina Univ., Chapel Hill (USA). Dept. of Bacteriology and Immunology). 1977. Contract EY-76-S-05-3628. 9p. Dep. NTIS, PC A02/MF A01.

Progress is reported on the following research projects: characterization of the III f granules of human neutrophil polymorphonuclear granulocytes (PMN); studies on glycosidases using methylumbelliferyl derivatives of the sugars with spectrofluorometry; distribution of proteinases and cationic proteins in human PMN; comparison of granules of eosinophils with those of other PMN; identification of a cyanide-resistant NADPH oxidase in PMN; subcellular localization of superoxide dismutase in PMN; oxygen-independent antimicrobial activities of each granule class; the phagocytic and intraleukocytic killing capacity of PMN deprived of their specific granules with phorbol myristate acetate; and studies on the PMN of an infant with the Chediak Higashi syndrome. (HLW)

57414 (SAN—326P32X15) **Studies on the repair of damaged DNA in bacteriophage, bacterial, and mammalian systems. Three year progress report.** (Energy Research and Development Administration, San Francisco, Calif. (USA). San Francisco Operations Office). 1977. Contract EY-76-S-03-0326-032. 23p. Dep. NTIS, PC A02/MF A01.

Progress is reported on the following research projects: nucleotide excision repair of uv-irradiated DNA in bacteriophage, bacteria, and mammalian cell systems; base excision repair of DNA in Bacillus subtilis; studies on semi-conservative DNA synthesis in mammalian cells; and studies on photoreactivation in mammalian cells. (HLW)

57415 Characterization and induction of aryl hydrocarbon [benzo(a)pyrene] hydroxylase in rabbit bone marrow. Andrews, L.S.; Sonawane, B.R.; Yaffe, S.J. (Univ. of Pennsylvania, Philadelphia). *Res. Commun. Chem. Pathol. Pharmacol.;* **15**: No. 2, 319-330(Oct 1976).

Benzo(a)pyrene hydroxylase activity was found in the bone marrow of control and 3-methylcholanthrene(3MC)-induced New Zealand white rabbits. This activity was localized in the microsomal fraction, was NADPH dependent and CO sensitive. The reaction was inhibited by 7,8-benzoflavone indicating that it was mediated by the 3MC-inducible form of cytochrome P-450. BP hydroxylase activity in rabbit bone marrow was located primarily in white cells, and was considerably higher than that previously reported for cultured human lymphocytes and monocytes. A possible role for the bone marrow mixed-function oxygenase in the production of hemopoietic toxicity is considered.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 57455

CYTOLOGY

REFER ALSO TO CITATION(S) 57413

57416 (LA-UR—77-365) **Flow microfluorometric and spectrophotofluorometric analysis of DNA staining in mammalian cells.** Crissman, H.A.; Stevenson, A.; Kissane, R.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 1p. (CONF-770324—3). Dep. NTIS, PC A02/MF A01.

From 3. international conference on impulse cytophotometry; Vienna, Austria (30 Mar 1977).

The effects of pH, ionic strength, stain concentration, and magnesium concentration on DNA staining with the antibiotics mithramycin, chromomycin A3, and olivomycin were examined with DNA in solution and in mammalian cells. Ethanol-fixed Chinese hamster cells (line CHO) stained with mithramycin solution in the pH range 4.0 to 10.0 and analyzed by flow microfluorometry (FMF) showed only a slight increase in fluorescence intensity from pH 4.0 to 8.0. Above this range, there was a more dramatic increase in intensity of stained cells, and at pH 10.0 the flouorescence intensity was 1-1/2 times greater than cells stained at pH 4.5. The resolution in DNA distribution patterns also improved as a function of increasing pH, corresponding with a marked decrease in the coefficient of variation (CV). However, the distribution of cells in various phases of the cell cycle remained essentially the same over the pH ranges tested.

57417 (LA-UR—77-992) **Mathematical analysis of DNA histograms from asynchronous and synchronous cell populations.** Jett, J.H. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 13p. (CONF-770324—4). Dep. NTIS, PC A02/MF A01.

From 3. international conference on impulse cytophotometry; Vienna, Austria (30 Mar 1977).

A technique is presented for the analyss of DNA histograms which is an extension of earlier discrete Gaussian summing methods. It alleviates the problems encountered with previous methods by extending the S-phase portions of the distribution under the G_1 and G_2 + M peaks. The resuts obtained by this method for the fraction of cells in the G_1, S, and G_2 + M phases of the life cycle are compared with autoradiographic results. With one or two exceptions which are discussed, agreement between autoradiography and the analytical method is good.

METABOLISM

REFER ALSO TO CITATION(S) 57406, 57449, 57450, 57451

57418 Simultaneous influx and efflux of nitrate during uptake by perennial ryegrass. Morgan, M.A.; Volk, R.J.; Jackson, W.A. (North Carolina State Univ., Raleigh). *Plant Physiol.;* **51**: 267-272(1973).

Experiments with intact plants of Lolium perenne previously grown with $^{14}NO_3^-$ revealed significant efflux of this isotopic species when the plants were transferred to solutions of highly enriched $^{15}NO_3^-$. The exuded $^{14}NO_3^-$ was subsequently reabsorbed when the ambient solutions were not replaced. When they were frequently replaced, continual efflux of the $^{14}NO_3^-$ was observed. Influx of $^{15}NO_3^-$ was significantly greater than influx of $^{14}NO_3^-$ from solutions of identical NO_3^- concentration. Transferring plants to $^{14}NO_3^-$ solutions after a six-hour period in $^{15}NO_3^-$ resulted in efflux of the latter. Presence of MG^{2+}, rather than Ca^{2+}, in the ambient $^{15}NO_3^-$ solution resulted in a decidedly increased rate of $^{14}NO_3^-$ efflux and a slight but significant increase in $^{15}NO_3^-$ influx. Accordingly, net NO_3^- influx was slightly depressed. A model in accordance with these observations is presented; its essential features include a passive bidirectional pathway, an active uptake mechanism, and a pathway for recycling of encogenous NO_3^- within unstirred layers from the passive pathway to the active uptake site.

57419 Nitrate uptake by dark-grown corn seedlings. Some characteristics of apparent induction. Jackson, W.A.; Flesher, D.; Hageman, R.H. (North Carolina State Univ., Raleigh). *Plant Physiol.;* **51**: 120-127(1973).

Five or six-day old seedlings of corn (Zea mays L.) were exposed to 0.25 mM $Ca(NO_3)_2$, 1.0 mM sodium 2-[N-morpholino]-ethanesulfonate, 5 μg Mo per liter and 50 μg of chloramphenicol per ml at pH 6. Nitrate uptake was determined from depletion of the ambient solution. The pattern of nitrate uptake was characterized, after the first 20 minutes, by a low rate which increased steadily to a maximal rate by 3 to 4 hours. Transfer of nitrate to the xylem did not totally account for the increase. Development of the maximal accelerated rate did not occur at 3°C with excised roots nor with seedlings whose endosperm had been removed. Use of $CaCl_2$ rather than $Ca(NO_3)_2$ resulted in a linear rate of chloride uptake during the first 4 hours, and chloride uptake was not as restricted by endosperm removal as with nitrate uptake. Nitrate pretreatments or the addition of cycloheximide (2 μg ml^{-1}), puromycin (400 μg ml^{-1}) and 6-methylpurine (0.5 mM) restricted maximal development of the accelerated nitrate uptake rate. Actinomycin D (20 μg ml^{-1}) inhibited the rate only after about three hours exposure. The RNA and protein synthesis inhibitors also restricted nitrate reductase induction in the apical segments of the root tissue. The data suggest that development of the maximal accelerated rate of nitrate uptake depended upon continuous protein synthesis, and the hypothesis that synthesis of a specific nitrate transport protein must occur is advanced. But the alternative hypothesis, i.e., that induction of nitrate reductase (and/or a consequence of the act of nitrate reduction) provided the required stimulus, remains tenable.

MEDICINE

TRACER TECHNIQUES

57420 Four-dimensional reconstruction of radioisotopic activity in the brain. Reich, T.; Youdin, M.; Rusinek, H. (New York Univ. Medical Center, New York). *Trans. Am. Nucl. Soc.;* **26**: 151(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57421 Studies of the heart with ECG-gated scintigraphy. Green, M.V. (National Inst. of Health, Bethesda, MD). *Trans. Am. Nucl. Soc.;* **26**: 151-152(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57422 Performance characteristics of the large field scintillation gamma cameras. Lim, C.B.; Hoffer, P.B.; Rollo, D.; Lilien, D. (Univ. of California, San Francisco). *Trans. Am. Nucl. Soc.;* **26**: 152(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57423 Role of midi-maxi computer interaction in nuclear medicine. Schlapper, G.A. (Univ. of Missouri, Columbia); Logan, K.W.; Bull, S.R.; Verdon, T.A. *Trans. Am. Nucl. Soc.;* **26**: 152-154(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57424 Digital modeling of a zone plate, gamma-ray imaging system. Kelly, K.A.; Redmond, R.F. (Ohio State Univ., Columbus). *Trans. Am. Nucl. Soc.;* **26**: 154(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57425 Fast iterative method for 3-D positron image reconstruction. Lim, C.B.; Cheng, A.; Boyd, D. (Univ. of California, San Francisco). *Trans. Am. Nucl. Soc.;* **26**: 154-155(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

PHYSIOLOGICAL SYSTEMS

57426 Lateralization model and the role of time-intensity tradings in binaural masking: Can the data be explained by a time-only hypothesis. Hafter, E.R. (Department of Psychology, University of California, Berkeley, California 94720). *J. Acoust. Soc. Am.;* **62**: No. 3, 633-635(Sep 1977).

In an earlier paper [J. Acoust. Soc. Am. 50, 1116—1122 (1971)] I presented a lateralization model of binaural masking-level differences (MLD's), according to which detection under conditions which produce an MLD is based on the average value of an interaural parameter, Δ. This factor is made up of interaural time (Δt) plus interaural intensity (ΔI) weighted by a binaural trading ratio (TR). Two figures in that paper depicted application of the model to MLD's found as a function of frequency [(Hirch and Burgeat, J. Acoust. Soc. Am. 30, 827—832 (1958)]; those figures are partially incorrect. They show the lateralization equation with a time-intensity trading ratio of 20 μsec/dB to be the best fit, when, in fact, the fit to TR=0 μsec/dB is excellent. The lateralization model with a trading ratio of 0 is very much like the vector model of Webster [J. Acoust. Soc. Am. 23, 452— 462 (1951)] and Jeffress et al. [J. Acoust. Soc. Am. 28, 416—426 (1956)]. It is suggested here that variability in the noise process may be significant factor, allowing binaural neurons tuned to high frequencies to recover and then respond again to interaural differences of time.

57427 Genetic influence on hypertension induced by cadmium in Dahl hypertension-resistant and hypertension-sensitive rats. Ohanian, E.V.; Dahl. L.K.; Iwai, J. (Brookhaven National Lab., Upton, NY). pp 451-457 of In Trace substances in environmental health. X. Hemphill, D.D. (ed.). Columbia, MO; Univ. of Missouri (1976).

Dahl hypertension-resistant (R) and hypertension-sensitive (S) rats, with opposite genetically controlled propensities for hypertension, were used to determine whether cadmium-induced hyperten-

sion was also dependent upon genetic predisposition. When intraperitoneal injections of Cd (1 and 2 mg/kg) were given to male and female R and S rats maintained under ordinary laboratory conditions, female S rats manifested a significant increase ($p < 0.01$) in blood pressure which persisted for 16 weeks, whereas the R rats and the male S rats showed no significant changes in blood pressure. Cadmium had no effect on body weight. The concentrations of Cd in hepatic and renal tissues of Cd-injected male and female S rats were significantly higher ($p < 0.001$) than that of R rats. The kidneys of female S rats given Cd showed renal vascular changes in accord with renal hypertension of moderate degree. We concluded that differences in genetic substrate influence the pathogenesis of experimental Cd-induced hypertension.

BIOMEDICAL SCIENCES, APPLIED STUDIES

EXTERNAL SOURCE

REFER ALSO TO CITATION(S) 57414

BASIC STUDIES

REFER ALSO TO CITATION(S) 57414

RADIATION EFFECTS ON ANIMALS

MAN

57428 (CONF-770615—2) **Radiation safety.** Auxier, J.A. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 25p. MF A01.

From National conference on campus safety on the University of Hawaii Campus; Honolulu, Hawaii, United States of America (USA) (9 Jun 1977).

Data available on the biological effects of radiation on man are reviewed, with emphasis on dose response to low LET and high LET radiation sources, and the effects of dose rate. Existing guides for radiation protection were formulated largely on the basis of tumor induction in the bone of radium dial painters, but the ICRP/NCRP annual dose guides of 5 rem/yr are of the same general magnitude as the doses received in several parts of the world from the natural radiation environment. Because of the greater sensitivity of rapidly dividing cells and the assumption that radiation occupations would not begin before the age of eighteen, maximum exposure levels were set as 5 (N-18) rem/yr, where N is the exposed worker's age in years. However, in the case of the natural radiation environment, exposure commences, in a sense, with the exposure of the ovum of the individual's mother; and the ovum is formed during the fetal development of the mother. In occupational exposures, the professional health physicist has always practiced the as low as practical philosophy, and exposures have generally averaged far below the guidelines. The average annual exposure of the radiation worker in modern plants and laboratories is approximately equal to the average natural radiation environment exposure rate and far lower than the natural radiation environment in many parts of the world. There are numerous complications and uncertainties in quantifying radiation effects on humans, however, the greatest is that due to having to extrapolate from high dose levels at which effects have been measured and quantified, to low levels at which most exposures occur but at which no effects have been observed.

57429 (NIRS-M—10, pp 70-74) **Current methods of internal dose estimation.** Yabe, A. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). Oct 1975. (In Japanese).

From 2. National Institute of Radiological Sciences seminar; Chiba, Japan (28 Feb 1975).

In Fundamental aspects of marine radioecology. I.

Three different methods of estimating internal radiation doses to organs of human body are briefly described and reviewed. These are the method recommendated for calculation of dose equivalent by Committee 4 of the International Commission on Radiological Protection, the method developed for absorbed dose calculation by the Medical Internal Dose Committee of the Society of Nuclear Medicine (USA), and the method used in computing MPC values in sea waters and introduced as a specific activity approach by the National Academy of Science and the National Research Council (USA).

57430 (NUREG—0301) **Regulation of naturally occurring and accelerator-produced radioactive materials. A Task Force review.** Nussbaumer, D.A.; Lubenau, J.O.; Cool, W.S.; Cunningham, L.J.; Mapes, J.R.; Schwartz, S.A.; Smith, D.A. (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Material Safety and Safeguards). Jun 1977. 74p. Dep. NTIS, PC A05/MF A01.

The use of accelerator-produced radioisotopes (NARM), particularly in medicine, is growing rapidly. One NARM radioisotope, ^{226}Ra, is one of the most hazardous of radioactive materials, and ^{226}Ra is used by about 1/5 of all radioactive material users. Also, there are about 85,000 medical treatments using ^{226}Ra each year. All of the 25 Agreement States and 5 non-Agreement States have licensing programs covering NARM users. The Agreement States' programs for regulating NARM are comparable to their programs for regulating byproduct, source, and special nuclear materials under agreements with NRC. But there are 7 states who exercise no regulatory control over NARM users, and the remaining States have control programs which are variable in scope. There are no national, uniformly applied programs to regulate the design, fabrication and quality of sources and devices containing NARM or consumer products containing NARM which are distributed in interstate commerce. Naturally occurring radioactive material (except source material) associated with the nuclear fuel cycle is only partially subject to NRC regulation, i.e., when it is associated with source or special nuclear material being used under an active NRC license. The Task Force recommends that the NRC seek legislative authority to regulate naturally occurring and accelerator-produced radioactive materials for the reason that these materials present significant radiation exposure potential and present controls are fragmentary and nonuniform at both the State and Federal level.

57431 (PB—264888) **Non-ionizing radiation protection training manual for radiation control. Lectures, demonstrations, laboratories and tours on the course on non-ionizing radiations. Final report.** Morgan, K.Z.; Burkhart, R.L. (Georgia Inst. of Tech., Atlanta (USA). School of Nuclear Engineering). Mar 1976. 951p. NTIS PC A99/MF A01.

In late 1974, consultation with the National Training Coordination Committee of the Conference of Radiation Control Program Directors determined that State personnel needed training in order to fulfill their responsibility with respect to the growing number of non-ionizing radiation sources. A contract was awarded to the Georgia Institute of Technology to develop materials for a training program on non-ionizing radiation protection, pilot test these materials in a two-week presentation for Federal, State, and local government health personnel, and revise the materials as needed to produce a self-contained training manual. The materials were pilot-tested in March 1976, and then revised to provide the final manual. The course consists of three parts (1) general discussions of basic principles, properties, propagation and behavior of all types of nonionizing radiations (2) an indepth study of all types and applications of coherent (laser) radiations, and (3) a study of ultraviolet, infrared, microwave, r.f., longwave and mechanical radiations as they may be used to have applications in hospitals and other medical institutions.

57432 **Estimation and control of population dose within buildings.** Moeller, D.W.; Underhill, D.W.; Gulezian, G.V. (Harvard School of Public Health, Boston). *Trans. Am. Nucl. Soc.;* **26**: 117(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57433 **Anti ultraviolet-irradiated DNA antibodies in xeroderma pigmentosum patients.** Slor, H.; Nivy, S.; Cleaver, J.E.; Friedberg, E.C. pp 5-10 of In DNA repair and late effects. Altman, H. (ed.). Vienna; Rotzer-Druck Publishers (1975).

Antibodies against uv-irradiated DNA were detected in two xeroderma pigmentosum patients of the common type. No such antibodies were detected in two XP patients of the variant type (normal levels of unscheduled DNA synthesis), and in normal and systemic lupus erythematosus (SLE) individuals. The presence of uv-DNA antibodies in XP may account for some of the autoimmune-like symptoms present in many such patients.

VERTEBRATES

57434 (COO—2012-27) **Biochemical studies on the ocular lens in relation to cataractogenesis. Progress report, July 1, 1975—May 31, 1977.** Kinsey, V.E.; Reddy, V.N. (Oakland Univ., Rochester, Mich. (USA). Inst. of Biological Sciences). 1977. Contract EY-76-S-02-2012. 13p. Dep. NTIS, PC A02/MF A01.

Further studies were undertaken to determkine whether γ-glutamyl cycle is involved in transporting amino acids from aqueous humor into the lens. Oxoproline levels in rabbit lenses cultured in the presence of methionine and a specific inhibitor of oxoprolinase (imidazolidone-carboxylic acid) and in lenses of rats injected with the inhibitor and the amino acid were found to be unaffected. Investigations of x-irradiated rabbit lenses have shown that the level of reduced glutatbione decreased by 75% three weeks prior to cataract formation while levels of oxidized GSH and protein bound GSH remained unaltered, indicating that GSH synthesis has been reduced or that the tripeptide is lost through leakage out of the lens. Cataractous lenses from x-rayed rabbits showed a decrease in the

relative amount of β and γ-crystallins and an increase in α-crystallin and high molecular weight protein aggregates. The development of galactose cataract in lenses from galactose fed rats was investigated to study more accurately changes in active and passive transport of sodium, potassium, and chloride. Results of sodium flux experiments suggest that sodium transport is unimpaired during initial stages of cataract formation, a conclusion consistent with the observation that the level of lens sodium is only slightly elevated. Unlike sodium transport, the turnover rate of potassium increased bya factor of two, while the active accumulation decreased fourfold. In order to evaluate more completely changes in cation and anion concentrations in cataractous lenses, bioelectric potentials were measured and observed to decline gradually over thirteen days, followed by a sudden loss of potential on the fourteenth day when nuclear opacities became visible.

57435 (COO—3017-31) **Radiation carcinogenesis. Progress report IV, 15 March 1976—15 May 1977.** Warren, S.; Gates, O. (New England Deaconess Hospital, Boston, Mass. (USA). Cancer Research Inst.). 1977. Contract EY-76-S-02-3017. 15p. Dep. NTIS, PC A02/MF A01.

The series of parabiont and irradiated rats has been completed, the lesions diagnosed and the data pertinent to tumors computerized and partly analyzed. The same series yielded 74 percent incidence of cataract in the irradiated partner following a whole-body dose of 1000 R with 0.2 percent in the shielded partner and also in controls. There was no abscopal effect. Other structures of the eye beside the lens, particularly the retina, showed extensive radiation damage. Parabiosis increased the incidence rate of leukemia from one percent in control single rats to five percent. Irradiation of one partner decreased the rate to 2.5 percent. Similar effects were noted for solid lymphoid tumors. A pilot study of prostatic cancer in irradiated parabiont rats demonstrated a tenfold increase in incidence. Experimental protocols bearing on cocarcinogenesis have been initiated in mice and rats, using radiation, asbestos and chemical carcinogens, but no results have been as yet obtained. We have obtained additional evidence suggesting the importance of prolactin as a cocarcinogen with radiation for induction of mammary tumors in the rat and are continuing our collaborative study of hormonal aasays in the blood of parabiont rats.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

REFER ALSO TO CITATION(S) 57382

57436 (BNWL-SA—5855) **Plutonium in human lung in the Hanford environs.** Nelson, I.C.; Thomas, V.W. Jr. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1977. Contract EY-76-C-06-1830. 8p. (CONF-770409—9). Dep. NTIS, PC A02/MF A01.

From 4. congress of the International Radiation Protection Agency; Paris, France (24 Apr 1977).

The measured and theoretical results compare closely. In most cases the average concentration of the set was within a factor of 5 of the theoretical estimate. The marked decrease in measured concentrations of plutonium in lung from 1966 to 1970 coincided with an approximate tenfold increase in tissue sample size. That period was also one in which fallout concentrations decreased. Caution should be used in developing conclusions from these results because many of the sample results during this time and earlier were "less thans," and their true value may have been substantially less than that shown. The apparent increase in measured concentrations of plutonium in lung in the period 1971-1974 is not understood. The new alpha spectrometry procedure was used on these samples, and some systematic error in earlier work may be suggested. The possibility of a small contribution from Hanford facilities cannot be absolutely ruled out. The average concentration in lung over the period covered (assuming a "less than" value to be at detection limit) was 0.5 fCi/g of lung, and the average of the maximum values noted was 0.8 fCi/g. For comparison, the theoretical average value where it is assumed that each year since 1965 an individual is autopsied was 0.4 fCi/g. If Hanford facilities have contributed to the plutonium content of lungs in individuals residing in the environs, that contribution would appear at most to be about that from worldwide fallout. But, more likely, the plutonium in lung derives almost totally from fallout, and the Hanford conribution is negligible by comparison.

57437 (UCRL—51879(Pt.5)) **Dose assessment at Bikini Atoll.** Robison, W.L.; Phillips, W.A.; Colsher, C.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Jun 1977. Contract W-7405-ENG-48. 51p. Dep. NTIS, PC A04/MF A01.

Bikini Atoll is one of two sites in the northern Marshall Islands that was used by the United States as testing grounds for the nuclear weapons program from 1946 to 1958. In 1969 a general cleanup began at Bikini Atoll. Subsistence crops, coconut and Pandanus fruit, were planted on Bikini and Eneu Islands, and housing was constructed on Bikini Island. A second phase of housing was planned for the interior of Bikini Island. Preliminary data indicated that external gamma doses in the interior of the island might be higher than in other parts of the island. Therefore, to select a second site for housing on the island with minimum external exposure, a survey of Bikini Atoll was conducted in June 1975. External gamma measurements were made on Bikini and Eneu Islands, and soil and vegetations samples collected to evaluate the potential doses via terrestrial food chains and inhalation. Estimates of potential dose via the marine food chain were based upon data collected on previous trips to the atoll. The terrestrial pathway contributes the greater percentage, external gamma exposure contributes the next highest, and inhalation and marine pathways contribute minor fractions of the total whole body and bone marrow doses. The radionuclides contributing the major fraction of the dose are ^{90}Sr and ^{137}Cs. All living patterns involving Bikini Island exceed federal guidelines for 30-yr population doses. The Eneu Island living pattern leads to doses that are slightly less than federal guidelines. All patterns evaluated for Bikini Atoll lead to higher doses than those on the southern islands at Enewetak Atoll.

PLANTS

REFER ALSO TO CITATION(S) 57437

NUCLIDE KINETICS AND TOXICOLOGY

57438 **Isotope chemistry and biology.** Katz, J.J.; Uphaus, R.A.; Crespi, H.L.; Blake, M.I. pp 184-205 of In Isotopes and chemical principles. Rock, P.A. (ed.). Washington, DC; American Chemical Society (1975).

From 167. national meeting of the American Chemical Society; Los Angeles, California, USA (31 Mar 1974).

See CONF-740349—P6.

The biological effects of deuterium, ^{13}C, ^{15}N, and multiple isotope substitution are reviewed. (JSR)

ANIMALS

57439 (CONF-770673—1) **Biokinetics of Tl-201 in mice after intravenous and oral administration of TlCl.** Tsui, B.M.W.; Gloria, I.V.; Lathrop, K.A. (Chicago Univ., Ill. (USA)). 1977. 13p. Dep. NTIS, PC A02/MF A01.

From 24. annual meeting of the Society of Nuclear Medicine; Chicago, Illinois, USA (23 Jun 1977).

Carrier-free ^{201}Tl was administered to fasting mice orally and intravenously. Data were collected at $^1/_2$ minute intervals up to 7 days. Results are discussed with regard to the following: tissue distribution curves following intravenous injection; comparison of heart-to-blood and heart-to-lung ratios from intravenous and oral administration, and comparison of experimental data with results from compartment model calculations. The rate constants obtained from the compartment model analysis are useful in understanding the physiological and biochemical kinetics of ^{201}Tl in the intact subject. (HLW)

57440 (N—77-16683) **Binders of intravenously administered 65-zinc in rat liver cytoplasm.** Stortenbeek, A.J.; Vandenhamer, C.J.A. (Interuniversitair Reactor Instituut, Delft (Netherlands)). 1976. 24p. (IRI—33-76-02). NTIS PC A02/MF A01.

Submitted for Publication.

The fate of an intravenously injected trace dose of Zn-65(2+) in the rat was studied over a period of 10 days after injection. Tissue distributions were determined and a special study was made of Zn-65 binders in liver cytoplasm with apparent molecular weights of about 113,000, 66,400, 47,400, 29,000, 23,000, and 11,400. A time study showed that 4 hr after the injection, the most prominent cytoplasmatic Zn-65 binders are the 133,000, 66,400, and 23,000 molecular weight fractions. A tentative identification of the main Zn binders in the six Zn-65 fractions is given, using the collected data regarding their apparent molecular weight, time dependent prominence, and content of stable Zn.

PLANTS

REFER ALSO TO CITATION(S) 57380

THERMAL EFFECTS

VERTEBRATES

57441 (PB—264914) **The age and growth of the largemouth bass 'Micropterus salmoides' (lacepede), in a thermally loaded reservoir.** Busacker, G.P. (Missouri Univ., Columbia (USA). School of Forest-

ry, Fisheries and Wildlife). Aug 1971. Contract DI-14-31-0001-3296. 131p. NTIS PC A07/MF A01.

Thesis.

The age and growth of largemouth bass was studied in a thermally loaded 4,500 acre-reservoir. Growth of fish from the Hotwater Arm was compared to that from a Control Arm. Maximum discharge temperature was 37C which elevated the Hotwater Arm 0.5-11.5C above the Control Arm. The reservoir was formed in 1966, clear for 3 years, but became turbid in '69-'70, the time of the study. Heated water had no effect on water quality. Checks formed on the scales in winter and summer which made age and growth analysis difficult. No differences were found between body-scale relationships or condition factors. Heated water had these measurable effects upon the bass: (1) Annulus formation occurred one month earlier; (2) it extended the growing season and annual increment of growth; (3) bass were attracted to heated water and provided an excellent winter fishery. Heated water had no apparent deleterious effects on largemouth bass.

57442 pH and haemoglobin oxygen affinity in blood from the antarctic cod Dissostichus mawsoni. Qvist, J.; Weber, R.E.; DeVries, A.L.; Zapol, W.M. (Gentofte Hospital, Hellerup, Denmark). *J. Exp. Biol.;* 67: 77-88(Apr 1977).

Blood pH in the antarctic cod (Dissostichus mawsoni) and in two Trematomus species, occurring at -1.9°C, is extremely high (approximately 8.2 to 8.3). This supports and extends Rahn's (1966) model for the temperature-pH relationship in cold-blooded vertebrates. The blood of D. mawsoni shows a low oxygen affinity (P_{50} approximately equal to 14.5 mmHg at pH 8.16 and -1.9°C). Despite normal in vitro temperature and pH sensitivities, blood P_{50} increases only slightly when live fish are temperature-stressed (+4.0°C), or become acidotic as a result of agitational stress (blood pH 7.71), primarily as a result of compensatory decreases in blood ATP levels. Oxygen-binding properties of "stripped" (cofactor-free) solutions of D. mawsoni hemoglobin were measured in attempts to elucidate the molecular mechanisms involved in the function of the pigment.

57443 Impact of thermal effluents on fish. Miller, S. (Univ. of Guelph, Ont.). *Environ. Biol. Fishes;* 1: No. 2, 219-222(1977).

The potential hazards of thermal pollution to aquatic life are discussed. Today, significant heat loads are discharged in condenser cooling water from increasing numbers of steam-electrical generating plants, both fossil-fuel and nuclear. An operational definition of thermal pollution is given as "an environmental change which alters the species diversity more than 20% from the empirically determined level." Effects of heat pollution include: reduced capacity of water to hold O_2, abnormal life cycles of aquatic organisms physiological changes, thermal shock, cessation of spawning behavior, synergistic action with other pollutants, and heat death. (CAJ)

57444 Magnitude and ecological implications of thermal inertia in skipjack tuna, Katsuwonus pelamis (Linnaeus). Neill, W.H.; Chang, R.K.C.; Dizon, A.E. (Southwest Fisheries Center, Honolulu, Hawaii). *Environ. Biol. Fishes;* 1: No. 1, 61-80(1976).

The paper discusses results of experiments or the heat exchange processes used in skipjack tuna thermoregulation and the role of large thermal inertia in tuna ecology. The results indicated that skipjack tuna exchanged core heat with the environment only about 60% as rapidly as did typical telcosts and even somewhat more slowly than did air-breathing aquatic reptiles. (JWP)

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 55938

57445 (ORNL/TIRC—77/6) Toxicology Information Response Center literature search index, June 1976—May 1977. III. 2601—3100. Huff, J.E.; Gerstner, H.B.; Warren, H.S.; Waters, E.M.; Winslow, S.G.; Black, S.A.; Drago, N.P. (Toxicology Information Response Center, Oak Ridge, Tenn. (USA)). Aug 1977. Contract W-7405-ENG-26. 77p. Dep. NTIS, PC A09/MF A01.

This document details the latest collection of 500 literature searches accomplished by the Toxicology Information Response Center (TIRC). These computer-generated listings consist of three sections; with a permuted title index for easy entry.

57446 Impact and fate on aquatic environments of copper from nuclear power plants. Harrison, F.L.; Emerson, R.R.; Rice, D.W. Jr. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.;* 26: 110-111(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

INVERTEBRATES

57447 Effects of environmental factors on radiocadmium uptake by four species of marine bivalves. Jackim, E.; Morrison, G.; Steele, R. (Environmental Protection Agency, Narragansett, RI). *Mar. Biol.;* 40: No. 4, 303-308(19 Apr 1977).

Temperature, salinity, bottom-sediment type, and zinc concentration all influenced Cd uptake by 4 marine bivalves (Mya arenaria, Mytilus edulis, Mulinia lateralis and Nucula proxima) in short-term static assay systems using ^{109}Cd as a tracer. The experimental system consisted of aquaria containing 20 l of seawater maintained under controlled light and temperature conditions. The water contained either 5 or 20 μg/l Cd and tracer. Distribution and kinetics of the metal were monitored in the water column and organisms. The results demonstrate that Cd uptake rates differed widely among the organisms tested. An increase in temperature increased Cd uptake rate by all test organisms. A decrease in salinity increased Cd uptake by all organisms tested. The presence of bottom sediment depresses Cd accumulation in some benthic animals. Zinc in concentrations of 0.5 mg/l substantially decreased Cd uptake by Mytilus edulis and Mulinia lateralis. It is suggested that all important species and environmental variables be considered when studying heavy-metal uptake by marine organisms or when establishing water-quality criteria.

57448 Chemical composition and effects of water extracts of petroleum on eggs of the sand dollar Melitta quinquiesperforata. Nicol, J.A.C.; Donahue, W.H.; Wang, R.T.; Winters, K. (Univ. of Texas, Port Aransas). *Mar. Biol.;* 40: No. 4, 309-316(19 Apr 1977).

Sperm and eggs of sand dollars, Melitta quinquiesperforata (Leske), were subjected to two petroleum oils, and effects determined. The oils chosen were Kuwait crude and No. 2 fuel oil, supplied by the American Petroleum Institute. Water-soluble extracts (WSF) from oil-sea water mixes were prepared and the major aromatic components in the WSF of the fuel oil were identified. WSF of No. 2 fuel oil depressed respiration, mobility of sperm, interfered with fertilization and cleavage, and retarded larval development. The effects were detectable at dilutions of 4% and less (about 0.6 ppM of WSF). Kuwait crude was much less toxic. There was no effect on water permeability of the egg membrane. Results are compared with similar studies on other marine organisms.

57449 Effect of calcium on cadmium uptake by the shore crab Carcinus maenas. Wright, D.A. (Univ. of Newcastle upon Tyne, Eng.). *J. Exp. Biol.;* 67: 163-173(Apr 1977).

The accumulation of cadmium by the shore crab Carcinus maenas (L.) is to some extent dependent upon the calcium concentration of the external medium. This effect is apparently independent of the overall salinity of the external medium and may a least partially explain previous reports of a "salinity effect". Hemolymph cadmium has a highly significant inverse relationship with the external calcium concentration. This effect is less obvious with other tissues, although the whole body cadmium has a significant inverse correlation with the external calcium concentration. Both the hemolymph and gill show a significant inverse relationship between tissue cadmium and calcium. When postmolt animals were exposed to 20 μ-mol l^{-1} Cd in 100 percent s.w., high concentrations of both calcium and cadmium appeared in the hemolymph. Postmolt animals in cadmium-free sea water generally had a lower hemolymph calcium concentration than intermolt animals, and the rise in hemolymph calcium seen in the presence of cadmium may indicate some degree of competition for "deposition sites" between these two metals.

57450 Uptake of cadmium into the haemolymph of the shore crab Carcinus maenas: the relationship with copper and other divalent cations. Wright, D.A. (Univ. of Newcastle upon Tyne, Eng.). *J. Exp. Biol.;* 67: 147-161(Apr 1977).

When Carcinus was exposed to 20 μ-mol l^{-1} cadmium, the hemolymph cadmium level was initially dependent upon the salinity of the external medium. After 14 days the mean hemolymph cadmium level in 50 percent s.w. animals was nearly twice that of 100 percent s.w. animals. This trend was not sustained, however, and the situation was complicated by occasional inconsistent values. In both in vivo and in vitro conditions nearly all the hemolymph cadmium becomes bound to hemolymph protein within a few days. The relationship between hemolymph cadmium, copper and protein concentration has been investigated. Although the latter are highly correlated with each other, cadmium formed a significant positive relationship with hemolymph copper ($r = 0.523$) and protein ($r = 0.533$) only after 3 to 4 weeks uptake. Exposure to 20 μ-mol l^{-1} cadmium has no obvious effects on hemolymph protein and copper concentrations, which are clearly dependent on feeding status. Mortalities among experimental animals were often preceded by a rise in hemolymph cadmium concentration. This is usually seen before there are any obvious signs of tissue breakdown. Urine cadmium loss is probably unimportant as a pathway for the elimination of this metal. Urine cadmium concentrations often exceeded serum cadmium levels indicating that cadmium may sometimes be eliminated in bound form.

57451 Effect of salinity on cadmium uptake by the tissues of the shore crab Carcinus maenas. Wright, D.A. (Univ. of Newcastle upon Tyne, Eng.). *J. Exp. Biol.;* 67: 137-146(Apr 1977).

Cadmium accumulation by the hemolymph, gills and carapace of the shore crab Carcinus maenas (L.) was significantly higher in dilute sea water. This was reflected in the whole-body cadmium concentrations. There was no salinity effect with the hepatopancreas or muscle cadmium concentration. Over a 68-day period, cadmium was steadily accumulated by the carapace, with the salinity effect becoming increasingly apparent. In 50 percent sea water the gill cadmium concentration apparently reached a maximum level after about 2 weeks of uptake. This was eventually overtaken by the tissue cadmium concentration in the gills of 100 percent s.w. animals. After about 48 days the salinity effect had disappeared and the gill cadmium concentration of both 50 percent and 100 percent s.w animals (in 20 μ-mol Cd l^{-1} = 2.3 mg l^{-1} remained at approximately 0.3 μ-mol Cd g^{-1} (= 33.7 mg kg^{-1}) wet weight of tissue. The hepatopancreas cadmium also levelled off at about this concentration although no salinity effect was apparent. When animals loaded with cadmium for a 37-day period were returned to clean sea water, their whole body cadmium concentration fell by about 50 percent after 11 days. Losses from carapace and gills were important components of this reduction in cadmium concentration.

57452 Copper granules in the barnacle Balanus balanoides. Walker, G. (National Energy Research Council, Anglesey, Wales). *Mar. Biol.;* 39: No. 4, 343-349(11 Feb 1977).

Balanus balanoides (L.) collected from an area with high heavy-metal run-off contained two different types of granule within the parenchyma cells of the prosoma. X-ray microprobe analysis shows one to be the familiar "zinc" granule made up of concentric layers and giving major peaks for phosphorus and zinc, and the other to be homogeneous and giving peaks for sulfur and copper. this latter granule is designated the "copper" granule. Whilst "zinc" granules are known to be composed of inorganic phosphate, various tests on "copper" granules in sections and in a granule-rich pellet have shown that the copper is probably complexed with organic matter. The tests also demonstrated the relatively insoluble (inert) nature of these granules. Although "zinc" and "copper" granules were present together in the prosoma, atomic absorption analyses of whole bodies (prosoma + thorax) have shown the level of zinc (50.28 μg/mg dry weight) to be much higher than that of copper (3.75 μg/mg dry weight).

VERTEBRATES

REFER ALSO TO CITATION(S) 57353, 57396, 57415

57453 (CONF-770342—2) **Organ culture-cell culture system for studying multistage carcinogenesis in respiratory epithelium.** Steele, V.E.; Marchok, A.C.; Nettesheim, P. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 27p. Dep. NTIS, PC A03/MF A01.

From Symposium on mechanisms of tumor promotion and cocarcinogensis; Gatlinburg, Tennessee, United States of America (USA) (28 Mar 1977).

An organ culture-cell culture system was used to demonstrate carcinogen dose-dependent transformation of tracheal epithelial cells in vitro. Tracheal explants were exposed to MNNG (N-methyl-N^1-nitro-N-nitrosoguanidine) in organ culture. Outgrowths from these explants provided epithelial cell cultures. The numbers of long term epithelial cell cultures and cell lines that were established per explant increased as MNNG exposure concentration increased. At the present time, more cell lines derived from explants exposed to the highest MNNG concentration have produced palpable tumors than cell lines derived from explants exposed to lower MNNG concentrations. No cell lines were established from primaries derived from control explants. TPA (12-0-tetradecanoyl-phorbol-13-acetate), stimulates DNA synthesis in tracheal epithelium in organ culture in a manner simular to that described for mouse skin. Short exposures to TPA not only stimulated DNA synthesis earlier, but the stimulation was greater than that obtained with continuous exposure. At the present time, exposure of tracheal organ cultures to MNNG followed by TPA has resulted in an enhanced production of morphologically altered cells in primary epithelial cell cultures, than exposure to either agent alone.

57454 Trace metal toxicity in aquatic teleosts (fishes). Anderson, D.R. (Battelle Pacific Northwest Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* 26: 109-110(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57455 Mechanisms of dissolution of nickel subsulfide in rat serum. Kasprzak, K.S.; Sunderman, F.W. Jr. (Poznan Polytechnical Univ., Poland). *Res. Commun. Chem. Pathol. Pharmacol.;* 16: No. 1, 95-107(Jan 1977).

To elucidate the initial steps of carcinogenesis by nickel subsulfide, the mechanisms of dissolution of α-Ni_3S_2 were studied by incubating α-Ni_3S_2 dust in (a) water, (b) rat serum, and (c) rat serum ultrafiltrate. The sediments that remained following incubationn of α-Ni_3S_2 in the 3 media for 2 weeks were examined by x-ray diffractometry. The rates of solubilization of ^{63}Ni from α-$^{63}Ni_3S_2$ during incubation in the 3 media were measured by liquid scintillation counting. These studies showed that solubilization of Ni(II) from α-Ni_3S_2 in rat serum requires the presence of O_2 and involves three reactions: [I] 2α-$Ni_3S_2 + O^2 + 2H_3O$ 4 β-NiS + 2Ni $(OH)_2$; [II] β-NiS + $2O_2$ $Ni^{2+} + SO_4^{2-}$; and [III] Ni^{2+} and $Ni(OH)_2$ + serum ligands [albumin and amino acids] soluble Ni(II)-complexes. The rate of solubilization of ^{63}Ni from α-$^{63}Ni_3S_2$ was initially more rapid in rat serum than in serum ultrafiltrate and much more rapid than in water. After 2 days of incubation, the rates of dissolution of α-$^{63}Ni_3S_2$ in the 3 media became progressively retarded, probably owing to deposition of insoluble surface coatings of β-^{63}NiS and $^{63}Ni(OH)_2$ on the α-$^{63}Ni_3S_2$ particles.

57456 Effect of chlorine toxicity on certain blood parameters of adult rainbow trout (Salmo gairdneri). Zeitoun, I.H. (Consumers Power Co., Jackson, MI). *Environ. Biol. Fishes;* 1: No. 2, 189-195(1977).

In an effort to assess the mode of chlorine action on rainbow trout (Salmo gairdneri), hematocrit percentage, and hemoglobin, methemoglobin, reduced glutathione, plasma protein, and plasma hemoglobin concentrations were determined in four tests in which duplicate groups of approximately 15 fish each were exposed to 3.86, 2.47, 2.75, and 1.09 mq l^{-1} $TRCl_2$ for 8, 19, 20, and 29 minutes, respectively. Blood from fish exposed to chlorine was darker and thicker than that of the control. Chlorine seemed to diffuse readily through the gills, oxidizing the hemoglobin to methemoglobin and disrupting the erythrocyte membranes, resulting in hemolysis. Stress polycythemia was also due to the substantial increase of the hematocrit values and hemoglobin concentration. Hemoconcentration led to a significant rise in the reduced glutathione and plasma protein concentrations. The hemoconcentration seemed to interfere with the blood circulation and hinder the delivery of oxygen to tissues.

MAN

REFER ALSO TO CITATION(S) 57461

57457 (PB—264872) **Nitrogen oxides. Environmental health effects research series.** (National Research Council, Washington, D.C. (USA). Committee on Medical and Biologic Effects of Environmental Pollutants). Feb 1977. Contract EPA-68-02-1226. 503p. NTIS PC A22/MF A01.

This report is a review of current knowledge of the environmental health basis for control of manmade sources of nitrogen oxide emissions. The literature review covered the period through 1974. The principal subject areas considered in the report include: sources and control of atmospheric nitrogen oxides; analytical methodology; concentrations and chemical reactions in the atmosphere; and the effects of nitrogen oxides on human health, materials, vegetation, light transmission, and natural ecosystems. Emphasis is primarily on nitric oxide (NO) and nitrogen dioxide (NO_2), designated by the composite formula NO/sub x/ for nitrogen oxides. The major manmade source is the combustion of fossil fuel. Highest atmospheric concentrations are found in heavily populated, industrialized urban areas. Both acute and chronic health effects resulting from short-term and long-term exposures, are discussed in the report. Effects range from slight increases in airway resistance to death depending upon exposure concentrations.

57458 (PB—265115) **Risks from the storage of hazardous chemicals.** Solomon, K.A.; Rubin, M.; Okrent, D. (California Univ., Los Angeles (USA). Dept. of Energy and Kinetics). Dec 1976. 171p. (UCLA-ENG—76125). NTIS PC A08/MF A01.

The following approach was used to obtain information on storage of hazardous chemicals: (1) The governors of all fifty states were asked for information concerning the means used by the state in regulating and evaluating risks from storage of potentially hazardous chemicals; (2) A brief survey was made of the measures employed in the cities of Los Angeles and El Segundo, California, in regulating the construction and use of facilities to store hazardous chemicals; and (3) Parametric hazard calculations were performed for postulated accidents having assumed population distributions to provide a rough assessment of the potential hazard. A description of the method of surveying the states and the results obtained are given in Chapter II. The results obtained in the survey of Los Angeles and El Segundo are given in Chapter III. The methodology and results of the limited parametric study of potential hazards are reported in Chapter IV. Chapter V includes the computational model used for postulated accidents caused by different chemicals.

HEALTH AND SAFETY

57459 (CONF-770557—2) **Control of the level of NO/sub x/ in the indoor environment.** Macriss, R.A.; Elkins, R.H. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. 16p. of Gas Technology, Chicago, IL.

From 4. international clean air congress; Tokyo, Japan (16 May 1977).

This paper presents the results of a series of in-depth experimental studies to determine the extent to which combustion products from gas-fired unvented home appliances (particularly the range and oven) contribute to the NO/sub x/ levels in the home environment. The extent to which such concentration levels are affected by the level of cooking, natural infiltration, forced exfiltration, effect of air conditioning, and other factors is also discussed. A quantitative model which couples emission rates, ventilation rates, and dilution equations, verified by the above experimental results, is presented. Alternative approaches are also discussed aimed at control of short-term peak concentrations and 24-hour average levels of NO_2; comparison of the effectiveness of the approaches is specifically emphasized.

57460 (CONF-7605159—1) **Biohazards of energy production, distribution, use, and conservation: information sources.** Ulrikson, G.U.; Huff, J.E. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

From Symposium on the handling of toxicological information; Bethesda, Maryland, United States of America (USA) (27 May 1976).

The Information Center Complex is a large-scale information system that supports research programs in energy and the environment at ORNL. An organization chart of the complex shows five main areas: biomedical sciences, ecological and environmental sciences, physical sciences, social and economic sciences, and data base management operations. The complex provides seven major types of services: bibliographies, directories of researchers, inventories of current research projects, factual information, numerical data, organization of collected materials, and assessment of information. Each of these services is briefly discussed. (HLW)

57461 (UCRL—52258) **Evaluation of the hazard associated with fabricating beryllium copper alloys.** Senn, T.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 May 1977. Contract W-7405-ENG-48. 49p. Dep. NTIS, PC A03/MF A01.

Beryllium-copper alloys should be considered toxic materials and proper controls must be used when they are machined, heated, or otherwise fabricated. Air samples should be taken for each type of fabrication to determine the worker's exposure and the effectiveness of the controls in use. It has been shown that aerosols containing beryllium are generated during the four methods of fabrication tested, and that these aerosols can be reduced through local exhaust to undetectable levels. Considering the acute, chronic and possibly carcinogenic effects of exposure to beryllium, effective controls should be required because they are feasible both technologically and economically. The health hazards and control measures are reviewed.

57462 **Interdisciplinary graduate program to prepare science majors for careers in Radiation Health Physics.** Eckart, L.E. (Univ. of Cincinatti, OH). *Trans. Am. Nucl. Soc.;* **26**: 100-101(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

GEOSCIENCES

GEOLOGY AND HYDROLOGY

57463 (E—76-10453) **General study of the region of Lake Titicaca, Bolivia, using a satellite multispectral scanning system. Petrologic study of metamorphic rocks in the Zongo Valley in Bolivia. Installation project of a bacteria in the Los Monos Plains. Geological study of the Ulla Charzani region.** Brockmann, C.E. (National Aeronautics and Space Administration, Washington, D.C. (USA)). Apr 1976. 105p. NTIS $5.50.

No abstract available. (GRA)

57464 **Drilling/exploration activities.** Anon. *Pet. Eng.;* **49**: No. 1, 76-77(Jan 1977).

Electric log analysis for the stratigraphic test well drilled last year in the Baltimore Canyon Trough area indicates excellent reservoir conditions with good potential for hydrocarbon accumulation where traps are provided by geologic structures. According to the U.S Geological Surveys, sandstone considered effective as a potential reservoir rock forms 23% of the interval between 5000 ft and total depth of 16,043 ft. Details of organic carbon content, hydrocarbon concentrations, kerogens and geologic structures are provided. Weather conditions during test drilling are cited.

57465 **Modelling pore structure by 2-D and 3-D networks with application to sandstones.** Chatzis, I.; Dullien, F.A.L. (Univ of Waterloo, Ont). *J. Can. Pet. Technol.;* **16**: No. 1, 97-108(Jan-Mar 1977).

This investigation is a study of the properties of 2-dimensional (2-D) and 3-D network models of capillary tubes generalized for any pore size distribution. Generalized saturation plots for the accessibility of pores and the pseudo dead-end pore fractions were established. Fairly good simulations of the experimental capillary pressure curve and the accessibility of pores were obtained in the case of 3-D networks by assuming that the volume of a capillary segment is proportional to its entry diameter. 25 refs.

57466 **Biostratigraphy and taxonomy of devonian megaspores, arctic canada.** Chi, B.I.; Hills, L.V. (Br Pet, Calgary, Alberta). *Bull. Can. Pet. Geol.;* **24**: No. 4, 640-820(Dec 1976).

Late Middle and Upper Devonian megaspores and miospores were obtained from approximately 15,240 m (50,000 ft) of strata from seven sections in the Canadian Arctic. The palynomorphs recovered are assignable to 19 genera and 47 species. Seven assemblage zones, Givetian to Famennian in age, are established on the basis of the relative abundance and the first or last occurrence of characteristic species. By utilizing megaspore counts and some sedimentological data, the depositional environments were classified into continental, stable nearshore marine, unstable nearshore marine, and offshore marine. Maps are included at the end of the paper. Refs.

GEOPHYSICS

REFER ALSO TO CITATION(S) 57385, 57464

SEISMOLOGY AND TECTONICS

REFER ALSO TO CITATION(S) 56188, 56744, 56745

57467 **Geologic perspectives of earthquake hazards in East-Central United States.** Buschbach, T.C. (Illinois State Geological Survey, Urbana). *Trans. Am. Nucl. Soc.;* **26**: 126-127(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57468 **Problems of seismic risk analysis in the Northeast United States.** Pomeroy, P.W. (Roundout Associates, Stone Ridge, NY). *Trans. Am. Nucl. Soc.;* **26**: 127(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57469 **Relationship of seismicity to geology in the Northeastern United States.** Barosh, P.J. (Weston Observatory of Boston Coll.). *Trans. Am. Nucl. Soc.;* **26**: 127-128(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57470 **Studies related to the seismicity of the Charleston-Summerville Area, South Carolina.** Rankin, D.W. (Geological Survey, Reston, VA). *Trans. Am. Nucl. Soc.;* **26**: 128-129(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57471 **Earthquake activity in the Southeastern United States.** Bollinger, G.A. (Virginia Polytechnic Inst. and State Univ., Blacksburg). *Trans. Am. Nucl. Soc.;* **26**: 130(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57472 **Crustal structure and seismicity in Minnesota.** Walton, M. (Univ. of Minnesota, St. Paul). *Trans. Am. Nucl. Soc.;* **26**: 131(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57473 **Seismicity and tectonic relationships of the Nemaha Uplift in Oklahoma, Kansas, and Nebraska.** Luza, K.V. (Oklahoma Geological Survey, Norman). *Trans. Am. Nucl. Soc.;* **26**: 131-133(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

GEOPHYSICAL SURVEY METHODS

REFER ALSO TO CITATION(S) 55858

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 55647, 55693, 55701, 55708, 55737, 55738, 55828, 55908, 55918, 57463

57474 (UCRL—79011) **Empirical relation for dilatant behavior in brittle rocks.** Costantino, M.S.; Schock, R.N. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1977. Contract W-7405-ENG-48. 26p. (CONF-770706—12). Dep. NTIS, PC A03/MF A01.

From 6. AIRAPT international high-pressure conference; Boulder, Colorado, United States of America (USA) (25 Jul 1977).

A constitutive relation was developed for stress-volume strain states in brittle, low porosity rocks under uniaxial compressive stress. Analysis of laboratory data for a quartz sandstone, a granodiorite, and a granite yielded a relation that fits volume strain to within 1 percent for stresses up to near the failure stress. The fact that dilatancy in three dissimilar rocks can be described so well by a single, simple relation suggests that the physics of dilatancy is dominated by two mechanisms, an elastic response of the crack distribution to stress and the propagation of existing cracks.

57475 (Y/OWI/SUB—77/22303/1) **Data input manual for RSI/TRANCO: a finite element heat conduction computer program.** Callahan, G.D.; Fossum, A.F. (RE/SPEC, Inc., Rapid City, S.Dak. (USA)). 1 Feb 1977. Contract W-7405-ENG-26-SUB-89Y-22303C. 54p. Dep. NTIS, PC A04/MF A01.

This report addresses a rock mechanics problem in the National Waste Terminal Storage program, with the objective of storing radioactive wastes in deep geologic formations. This report provides information on input data as well as FORTRAN listing of RSI/TRANCO, which solves plane isotropic or anisotropic transient or steady state heat transfer problems. An example problem is presented to illustrate the mesh preparation, data input, and sample output. (DLC)

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 55645, 57464

57476 Evidence for the Azores mantle plume from strontium isotope geochemistry of the Central North Atlantic. White, W.M. (Univ. of Rhode Island, Kingston); Schilling, J.G.; Hart, S.R. *Nature (London);* **263**: 659-662(21 Oct 1976).

Strontium isotope variations in basalts from the Mid-Atlantic Ridge and the Azores Islands support the Azores mantle plume model. The similarity of isotope ratios in Mid-Atlantic Ridge tholeiites from the Azores platform and Azores Islands alkali basalts implies that these different magma types are derived from the same mantle source but under different conditions of origin.

57477 Mercury in underground waters of the West Siberian oil and gas bearing basin. Matusevich, V.M.; Prokop'eva, R.G. (Ukhta Ind Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 3-7(1976). (In Russian).

New data are presented on the content of mercury in deep underground waters in general and in those of the West Siberian Basin in particular. These data may be useful in forecasting estimates of the oil and gas potential of different territories. 14 refs.

OCEANOGRAPHY

REFER ALSO TO CITATION(S) 57353

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

57478 Los Alamos Scientific Laboratory observatory report. Sandford, M.T. II; Cox, A.N.; Jones, E.M. *Am. Astron. Soc., Bull.;* **8**: No. 1, 175-183(1976).

Very brief summaries of astronomical and astrophysical research at LASL are given. Recent highlights include determinations of the abundance of O, Si, and Fe as well as He in the solar wind; the first production of extensive opacity data including molecular effects for studies of stellar structure, evolution, and pulsation; calculations of variable stars which show more than one pulsation mode simultaneously; and further observations of cosmic γ-ray bursts. The overview is divided as follows: visitors; new research; facilities and equipment; current research--comets, galaxies, interstellar medium, magnetosphere and solar wind, numerical hydrodynamics, opacities and equations of state, radiative transfer and stellar atmospheres, relativistic astrophysics, satellite and rocket astronomy, solar physics, and variable stars; and publications in the fields of research. (RWR)

STARS

57479 Relative abundances of elements in main-sequence stars, and nucleosynthesis. Khokhlova, V.L. (Atronomical Council, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 1, 11-13(Jan 1977).

An analysis of the abundances of the chemical elements in the atmospheres of main-sequence stars shows that the abundance of the iron-peak elements compared to iron itself remains constant throughout the range of chemical composition, whereas the abundances of heavier and lighter elements exhibit a power-law correlation with the iron abundance. These relationships impose constraints on the physical conditions under which the elements were synthesized.

57480 Light curves of type II supernovae. Imshennik, V.S.; Utrobin, V.P. (Institute of Applied Mathematics, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 1, 34-37(Jan 1977).

The problem of non-LTE conditions in Grasberg, Imshennik, and Nadezhin's gas-dynamical model of type II supernovae is examined. Numerical calculations for a nonequilibrium model based on the equations of Compton radiative gas dynamics are compared with the results for the LTE model, and the disparities are discussed. A comparison is made between the theoretical light curves and observations of type II supernova events.

57481 CH lines in the spectrum of the magnetic variable 73 Draconis. Polosukhina, N.S.; Khokhlova, V.L. (Astronomical Council, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 1, 37-39(Jan 1977).

Lines of the CH molecule are identified in the spectrum of the Ap star 73 Dra. Their intensity varies with the same period as the magnetic variations. The CH lines are formed above the photospheric layers, and the temperature distribution in the atmosphere depends on the configuration of the magnetic field.

SOLAR PHENOMENA

57482 (N—77-16976) **Impulsive solar x-ray bursts. 3. Polarization and directivity of bremsstrahlung radiation from a beam of electrons directed toward the photosphere.** Langer, S.H.; Petrosian, V. (Stanford Univ., Calif. (USA). Inst. for Plasma Research). Jul 1976. Contract NGL-05-020-272. 20p. (NASA-CR—149452; SU-IPR—668). NTIS PC A02/MF A01.

The spectrum, directivity and state of polarization is presented of the bremsstrahlung radiation expected from a beam of high energy electrons spiraling along radial magnetic field lines toward the photosphere. The results are used for calculation of the characteristics of the reflected plus direct flux.

57483 (N—77—16977) **Impulsive solar x-ray bursts. 4: polarization, directivity and spectrum of the reflected and total bremsstrahlung radiation from a beam of electrons directed toward the photosphere.** Langer, S.H.; Petrosian, V. (Stanford Univ., Calif. (USA). Inst. for Plasma Research). Jul 1976. Contract NGL-05-020-272. 33p. (NASA-CR—149453; SU-IPR—669). NTIS PC A03/MF A01.

A Monte Carlo method is described for evaluation of the spectrum, directivity and polarization of X-rays diffusely reflected from stellar photospheres. The accuracy of the technique is evaluated through comparison with analytic results. By use of the characteristics of the incident X-rays of the model for solar X-ray flares, the spectrum, directivity and polarization of the reflected and the total X-ray fluxes are evaluated. The results are compared with observations.

57484 Radioactive nuclei and the gamma-ray background of the quiet Sun. Kuzhevskii, B.M. (Scientific Research Institute of Nuclear Physics, Moscow University). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 1, 13-14(Jan 1977).

Long-lived radioactive nuclei formed in the solar atmosphere during a flare could be responsible for the γ rays of the quiet Sun. A flux density $F\gamma = 10^{-7}$—10^{-5} $cm^{-2}xsec^{-1}$ of γ rays in the energy range $0.5 < \text{or} = E < \text{or} = 3$ MeV would be possible at the Earth.

GALAXIES

57485 (N—77-16980) **Al-26: a galactic source of gamma ray line emission.** Ramaty, R.; Lingenfelter, R.E. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Dec 1976. Contract NSF AST-76-08178. 11p. (NASA-TM-X—71262; X—660-76-284). NTIS PC A02/MF A01.

Submitted for Publication.

It is shown that ^{26}Al is a very good candidate for producing a detectable gamma-ray line, and that this line is not only intense but also very narrow. By examining the chart of nuclides for other radioactive isotopes which could produce hitherto unnoticed gamma-ray lines following nucleosynthesis, it is found that for mass numbers less than 60, the isotopes ^{22}Na, ^{26}Al, ^{40}K, ^{41}Ar, ^{44}Ti, ^{46}Sc, ^{54}Mn, ^{56}Co, ^{57}Co, ^{58}Co, ^{60}Co and ^{60}Fe are the only ones with sufficiently long half-lives (70 days) to produce gamma rays in optically thin regions.

57486 **Extinction towards the South Galactic Pole determined from reddening of A and F stars.** Knude, J.K. (Univ. Observatory, Copenhagen). *Astrophys. Lett.;* **18**: No. 3, 115-118(1977).

In eleven Selected Areas around the SGP 158 A and F stars with m/sub pg/ less than or equal to 10.0/sup m/ were observed in the uvby β-system in order to determine the reddening. A value E(B - V) = 0.057/sup m/ +- 0.004 (m.e.) is found, in agreement with nonphotometric estimates of the GP reddening.

57487 **Interstellar molecule formation.** Herbst, E. (William and Mary Coll., Williamsburg, VA); Klemperer, W. pp 62-75 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The present model for the specific synthesis of interstellar molecules may be summarized as cosmic ray ionization of H_2 and He followed by a variety of ion-molecule reactions. Neutral molecular species are in general formed from ions by dissociative recombination of ions and electrons. These reactions are entirely gas-phase two body processes. Several specific exceptions do exist. Hydrogen atom recombination to form molecular hydrogen must occur on grain surfaces. It is the one instance where a specific surface reaction occurs. There are probably some neutral-neutral reactions of interstellar consequence. These are reactions with no activation energy. An example is N + NO = N_2 + O. The reason for the preponderance of carbon compounds is the stability of C^+ due to the low ionization potential of C. The interesting question of how large organic molecules can be produced by C^+ or CH_3^+ reaction with organic molecules or CO reaction with organic molecular ions is presently unanswered. It certainly merits further laboratory study. It is likely that dissociative electron ion recombination will also place limits to the size of molecule that can be formed.

COSMOLOGY

57488 **Energy and pressure of fermion pairs created near the Friedmann singularity.** Mamaev, S.G.; Mostepanenko, V.M. (Lenin Electrical Engineering Institute, Leningrad). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 1, 25-26(Jan 1977).

The energy density and pressure are calculated for particles of spin 1/2 near a homogeneous and isotropic singularity. The fermion pairs created satisfy the equation of state of an ultrarelativistic gas. Since both energy density and pressure are negative, the energy dominance conditions for the matter created are violated.

PLANETARY PHENOMENA

REFER ALSO TO CITATION(S) 57341

57489 **Electron currents measured in the optical shadow of Venus by the "Venera-9" and "Venera-10" satellites; the basic source of ionization in the nightside ionosphere of Venus.** Gringauz, K.I.; Verigin, M.I.; Breus, T.K.; Gombosy, T. (Institute of Space Research, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Dokl. (Engl. Transl.);* **22**: No. 2, 53-56(Feb 1977).

Calculations are performed to demonstrate that the observed electron currents suffice for the ionization of the neutral atmosphere of Venus. The distribution function of the electrons is assumed to be isotropic.(AIP)

57490 **Early evolution of the terrestrial atmosphere and hydrosphere.** Mukhin, L.M.; Moroz, V.I. (Institute for Space Research, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 1, 39-41(Jan 1977).

A possible picture is outlined for the evolution of the primitive atmosphere and hydrosphere of the earth: the surface temperature would have been below 0°C initially (since the solar constant was lower than today), and the injection of CO_2 into the atmosphere would not have been balanced by Urey equilibrium processes because of the lack of contact with liquid water. The greenhouse effect in the primitive atmosphere would have melted the ice in the equatorial zone after a time interval of order 10^8 yr, when the CO_2 pressure had risen to 1 atm.

ATMOSPHERIC PHYSICS

AURORAL AND IONOSPHERIC PHENOMENA

57491 (N—77—16485) **Analysis of satellite data on energetic particles of ionospheric origin. Final report, 24 Mar. 1975 - 23 Mar. 1976.** Sharp, R.D.; Johnson, R.G.; Shelley, E.G. (Lockheed Missiles and Space Co., Sunnyvale, Calif. (USA). Space Sciences Lab.). 25 Feb 1976. Contract NASW-2777. 92p. (NASA-CR—149490; LMSC—D501012). NTIS PC A05/MF A01.

The principal result of this program has been the completion of a detailed statistical study of the properties of precipitating $O(^+)$ and $H(^+)$ ions during two principal magnetic storms. The results of the analysis of selected data of ion mass spectrometer experiments on satellites are given with emphasis on the morphology of the $O(^+)$ ions of ionospheric origin with energies in the O.7 < or = E < or = 12 keV range that were discovered with this experiment.

MAGNETOSPHERIC PHENOMENA

57492 (N—77-16979) **Charged-particle radiation environment for the Spacelab and other missions in low Earth orbit, revision A.** Watts, J.W. Jr.; Wright, J.J. (National Aeronautics and Space Administration, Huntsville, Ala. (USA). George C. Marshall Space Flight Center). 29 Nov 1976. 143p. (NASA-TM-X—73358). NTIS PC A07/MF A01.

Revised Supersedes NASA-TM-X—64936; N—7528001.

The physical charged particle dose to be encountered in low earth orbit Spacelab missions is estimated for orbits of inclinations from 28.5 to 90 deg and altitudes from 200 to 800 km. The dose encountered is strongly altitude dependent, with a weaker dependence on inclination. Doses range from 0.007 rads/day at 28.5 deg and 200 km to 1.57 rads/day at 28.5 deg and 800 km behind a 5.0 $g/^2$ shield. Geomagnetically trapped protons were the primary source of damage over most of the range of altitudes and inclinations, with galactic cosmic rays making a significant contribution at the lowest altitudes.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

BEAMS AND THEIR REACTIONS

REFER ALSO TO CITATION(S) 57521

57493 (N—77—16248) **Industrial ion source technology. Annual report.** Kaufman, H.R. (Colorado State Univ., Fort Collins (USA). Dept. of Physics). Nov 1976. 99p. (NASA-CR—135149). NTIS PC A05/MF A01.

A 30 cm electron bombardment ion source was designed and fabricated for micromachining and sputtering applications. This source has a multipole magnetic field that employs permanent magnets between permeable pole pieces. An average ion current density of 1 ma/cm^2 with 500-eV argon ions was selected as a design operating condition. The ion beam at this operating condition was uniform and well collimated, with an average variation of plus or minus 5 percent over the center 20 cm of the beam at distances up to 30 cm from the ion source. A variety of sputtering applications were undertaken with a small 10 cm ion source to understand better the ion source requirements in these applications. The results of these experimental studies are also included.

57494 **Sputtering of niobium by energetic neutrons and protons: A round-robin experiment.** Behrisch, R.; Harling, O.K.; Thomas, M.T.; Brodzinski, R.L.; Jenkins, L.H.; Smith, G.J.; Wendelken, J.F.; Saltmarsh, M.J.; Kaminsky, M.; Das, S.K.; Logan, C.M.; Meisenheimer, R.; Robinson, J.E.; Shimotomai, M.; Thompson, D.A. (Max-Planck-Institut fuer Plasmaphysik, EURATOM Association, D-8046 Garching/Munich, Germany). *J. Appl. Phys.;* **48**: No. 9, 3914-3918(Sep 1977).

This paper presents the results of a round-robin neutron-sputtering experiment in which six independent research groups have participated. Targets of cold-rolled niobium prepared by two standard techniques were used by all participants. Three participating groups used (d,t) neutrons of about 14.8 MeV, one group used (d,Be) neutrons produced by 40-MeV deutrons on a thick Be target, and two groups used 16-MeV protons in transmission. The emission of micrometer-sized particles was observed by two groups and not observed by the other four. This particle emission was observed by

two of the groups who used (d,t) neutrons in their irradiations. Chunk emission was observed for only one of the two standardized target types used in the round robin. The round-robin results support the concept that the neutron-sputtering yield of Nb, including atomic and chunk emission, has an estimated probable value no larger than 10^{-4} atoms per neutron. However, sputtering yields in the range 1.4 x 10^{-5} to < or approx. 2.6 x 10^{-3} are reported here. The probable value for the sputtering yield was found to be independent of the two target preparations and the method of analysis, whether or not chunks were observed during analysis.

57495 Model of secondary electron yields from atomic and polyatomic ion impacts on copper and tungsten surfaces based upon stopping-power calculations. Beuhler, R.J.; Friedman, L. (Chemistry Department, Brookhaven National Laboratory, Upton, New York 11973). *J. Appl. Phys.;* **48**: No. 9, 3928-3936(Sep 1977).

The calculation of the velocity dependence and magnitude of the kinetic secondary electron yield for atomic and polyatomic ions, denoted by gamma-bar/sub a/ and gamma-bar/sub m/, respectively, is modeled on stopping-power equations and compared to experimental results from the dynode materials copper and tungsten. From the experimental data, the relationship gamma-bar/sub m/ =Σgamma-bar/sub a/ is verified, which is necessary to the model calculation of gamma-bar/sub m/. The fundamental assumption of this model is that gamma-bar/sub a/ is proportional (even at low ion velocities) to the electronic stopping power (dE/dx)/sub e/ of that projectile in the target. Example calculations are performed for the velocity dependence of gamma-bar/sub a/ for hydrogen, carbon, and fluorine striking copper, and from these results the predicted gamma-bar/sub m/ curves for polyatomic ions are in close agreement with experiment. Analogous calculations for a tungsten surface are outlined and the final results are compared with experiment. The utility of the model is shown by illustrating that the measurement of gamma-bar can provide, not only a relative measurement of (dE/dx)/sub e/ for different ion atomic numbers on the same target, but can also provide a means of determining the nuclear stopping power (dE/dx)/sub n/ at low ion velocities where range measurements are difficult to perform. Values of (dE/dx)/sub n/ derived from measurements for fluorine and carbon striking copper are the same as values predicted by Lindhard and Scharff; for a tungsten target the experimental (dE/dx)/sub n/ values are a factor of 2 larger than theoretical. The relationship of the stopping power values derived from gamma-bar measurements with this model are compared to the values derived from ion range measurements.

57496 Simple, pulsed, electron beam gun. Brau, C.; Raybun, J.L.; Dodge, J.B.; Gilman, F.M. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Rev. Sci. Instrum.;* **48**: No. 9, 1154-1160(Sep 1977).

The construction of a simple, inexpensive electron beam gun is described. The pulsed power supply consists of a homemade spiral generator, constructed with aluminum and vinyl pressure-sensitive tapes, which is switched into the electron beam gun with a spark gap. The electron beam gun itself consists of a vacuum diode with a cold carbon cathode. From an initial charge voltage of 12 kV, the apparatus produces a 10-A beam of 100-keV electrons having a pulse duration of about 7 nsec and diameter of 6 mm.

57497 Trapping efficiency of molten lithium for 20-keV tritium ions. Fischer, A.K.; Steidl, D.V.; Brient, C.E.; Cafasso, F.A.; Johnson, C.E. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **63**: No. 2, 191-193(Jun 1977).

The trapping efficiency of molten lithium at 523 to 548°K for 20-keV T^+ ions was measured by a direct implantation technique to be 92% (the average of the measurements, 83 and 100%). Corrections were made for the presence of H_3^+ species in the ion beam.

57498 Investigation of plasmon excitation by oblique incidence of a beam of primary electrons of medium energy in reflection experiments. Bronshtein, I.M.; Krainskii, I.L.; Libenson, B.N. (A. I. Gertsen Pedagogical Institute, Leningrad). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 4, 558-561(Apr 1977).

A theoretical and experimental study was made of the excitation of surface and volume plasmons in Ca, Sr, and Be in the incidence-angle range α=0—88° and in the primary-electron energy range E/sub p/=50—500 eV. The amplitudes of the characteristic energy losses (CEL) corresponding to excitation of volume and surface plasmons are determined as functions of the angle α. The behavior of these functions is attributed to the presence of two mechanisms that produce the CEL (surface-plasmon excitation before and after the elastic reflection), and also to the effect of energy transfer from a surface plasmon to a volume plasmon at the metal—vacuum interface, where the electron plasma is spatially inhomogeneous.

57499 Electronic state alignment, orientation, and coherence produced by beam-foil collisions. Church, D.A. (Univ. of California, Berkeley). pp 660-671 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The cylindrically symmetric beam-fail collision produces excitation and alignment of atom and ion levels similar, but not identical, to that resulting at comparable energies from ion-atom or ion-molecule collisions. When the foil is tilted, the macroscopic change acts on the microscopic scale to produce coherent alignment and orientation of the excited levels. The maximum beam energy range bounding this interaction has not yet been defined. The dynamic interaction which produces these effects is currently not predicted by any theory, although the dynamics of the ions subsequent to the collision are well understood. Refinement of current experimental technique can be expected to better define the final foil surface. The beam-tilted-foil collision promises to be useful in the study of ionic structure via quantum beat, radio-frequency and level-crossing spectroscopy techniques, and may provide a useful probe for certain surface interactions.

57500 Ion-storage collision technique. Dehmelt, H.G. pp 857-870 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

A review of the development of the ion-storage collision technique is presented. The design and performance of ion sources are sketched and plotted. 30 refs. (JFP)

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 57550

57501 (ANL—77-3) Theoretical studies of the atmospheric triatomic molecules H_2O, N_2O, NO_2, CO_2, O_3, and their ions. Wahl, A.C.; England, W.B.; Rosenberg, B.J.; Hopper, D.G.; Fortune, P.J. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 66p. Dep. NTIS, PC A04/MF A01.

Definitive location of excited energy levels and the delineation of reaction mechanisms were provided by ab initio calculations of the triatomic atmospheric molecules and their ions. Linear geometry to bent geometry correlation diagrams were also determined. These provide simple ways of predicting reaction possibilities. Potential energy surfaces were computed for the ground $^2B_1$ and $^2B_2$ states of H_2O^+. Previous theoretical spectra of CO_2 were shown to be of limited accuracy and therefore experimental assgnments based on these are not definitive. Correlated results for the vertical excitation energies of O_3 are in very good agreement with experiments and with other calculations. The ground state potential energy surface of N_2O^- is characterized and related to the ground state potential energy surface of the neutral N_2O molecule by combining theoretical and experimental information. A definitive theoretical study provided energy levels for NO_2^+ and NO_2^-, and extension of previous studies on NO_2. Agreement between the two studies was good. (JSR)

57502 Electronic structure of the ground and excited states of Mg^+_2 and Mg_2 . Stevens, W.J.; Krauss, M. (Time and Frequency Division, National Bureau of Standards, Boulder, Colorado 80302). *J. Chem. Phys.;* **67**: No. 5, 1977-1989(1 Sep 1977).

The ground and excited valence states of Mg^+_2 and Mg_2 are calculated using the multiconfiguration self-consistent-field method. The energy curves of the X $^1\Sigma^+$/sub g/, $^3\Pi$/sub g/, $^3\Sigma^+$/sub u/, $^3\Pi$/sub u/, $^3\Sigma^+$/sub g/, $^1\Pi$/sub g/, $^1\Sigma$/sub u/$^+$, $^1\Pi$/sub u/, and 2 $^1\Sigma^+$/sub g/μ states of Mg_2 and the $^2\Sigma^+$/sub u/ and $^2\Pi$/sub μ/ curves of Mg^+_2 are obtained for internuclear separations between 4 and 15 bohr. All of the excited states except the $^3\Pi$/sub u/ and $^3\Sigma^+$/sub g/ are found to be bound while the ground state is a weakly bound van der Waals molecule. Comparison between the calculated and experimentally known X $^1\Sigma^+$/sub g/ and $^1\Sigma^+$/sub u/ energy curves shows good agreement for the equilibrium internuclear separation, but the calculated D/sub e/ (620 cm^{-1}) for the best approximation of the X $^1\Sigma^+$/sub g/ state exceeds the experimental value by about 40%, and the calculated D/sub e/ for the $^1\Sigma^+$/sub u/ state is smaller than the experimental value of 9387 cm^{-1} by about 1800 cm^{-1}. Analysis of the electronic structure of the excimers shows that the triplet states and the $^1\Pi$/sub g/ state are qualitatively described by covalent molecular orbital theory, but all of the other bound singlets require more complicated descriptions including covalent configurational mixing, charge transfer, and Rydberg—covalent configuration mixing. Only the $^1\Pi$/sub u/ state can be unambiguously characterized as a charge transfer state. The Mg_2 states were calculated to provide a model of the Group II excimer systems, which are candidates for the active media of lasers.

57503 Geometries and energies of the excited states of O_3 from ab initio potential energy surfaces. Hay, P.J.; Dunning, T.H. Jr. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* 67: No. 5, 2290-2303(1 Sep 1977).

The geometries and relative energies of the nine lowest states of the ozone molecule have been determined in C/sub 2v/ symmetry from ab initio configuration interaction calculations in a [3s2p1d] contracted Gaussian basis. Calculations were carried out over a two-dimensional grid of points in C/sub 2v/ symmetry to locate the optimum geometrical parameters R and θ for each state. For the ground $^1A_1$ state the calculated properties (with experimental values in parentheses) are as follows: R/sub e/=1.299 A (1.271 A), θ/sub e/=116.0° (116.8°), ω_1=1235 cm^{-1} (1110 cm^{-1}) and ω_3=707 cm^{-1} (705 cm^{-1}). Of the excited states only the lowest $^3B_2$ state is found to have an adiabatic excitation energy (0.92 eV) less than the dissociation energy (D/sub e/=1.13 eV) and hence to be a likely bound species. The $^1B_2$ state responsible for the strong absorption in the Hartley band (4.7—5.8 eV) is stabilized by asymmetric distortions away from its equilibrium C_2/sub v/ geometry (R/sub e/=1.405 A, θ/sub e/=108°); this finding suggests unequal bond lengths for this state or else purely dissociative behavior. The ring (2^1A_1) state (R/sub e/=1.449 A, θ/sub e/=60°) is found to lie 1.20 eV above the ground state, while the remaining five states have adiabatic excitation energies ranging from 1.4 to 3.6 eV. The implications for photodissociation of O_3 are discussed.

57504 Complete resolution of hyperfine structure in the close doublet λ5930.6 of ^{139}La by laser-atomic-beam spectroscopy. Childs, W.J.; Goodman, L.S. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Opt. Soc. Am.;* 67: No. 9, 1230-1234(Sep 1977).

The fluorescence excited in a ^{139}La atomic beam by a single-frequency dye laser in the region of 5930.6 A has been examined with Doppler-free geometry. The two lines are separated by 0.07 A, are entirely distinct, and 29 of the 30 hfs components are resolved. Computer fits to the observed hyperfine structure yield values for the dipole and quadrupole hfs constants of the upper ^{2}F/sub 5/2, 7/2/ states.

57505 Quasimolecular K x-rays. Meyerhof, W.E. (Stanford Univ., CA). pp 470-480 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The review of quasimolecular K x-rays includes mechanisms of molecular orbital x-ray production, quasistatic theory, and experimental results on the radiating system, the one- and two-collision processes, and impact parameter dependence. It is concluded that the experimental evidence should leave no doubt that molecular orbital K x-ray spectra exist. 37 refs. (JFP)

57506 Laser photodissociation of hydrogen molecule ions with fragment kinetic energy analysis. Durup, J. (Universite de Paris-Sud, Orsay, France). pp 609-623 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Ion photofragment data for laser photodissociation of the hydrogen molecule are reviewed. The possibilities offered by this method are shown. Vibrational populations of H_2^+, HD^+, and D_2^+ formed in electron-impact ionization are discussed. 32 refs. (JFP)

57507 Hyperfine structure of the highly excited states of alkali atoms. Gupta, R. (Columbia Univ., New York). pp 712-725 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The hyperfine structure of S, D, F, etc states of alkali atoms were studied using techniques of cascade fluorescence spectroscopy and stepwise laser spectroscopy. Emphasis is placed on the non-P states of these atoms. 19 refs. (JFP)

57508 Production and detection of highly excited states. Bayfield, J.E. (Yale Univ., New Haven). pp 726-737 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The discussion of the production and detection of highly excited states of atoms and molecules includes production by keV energy electron transfer collisions, production of slow highly excited atoms and molecules by electron impact, detection by field ionization, and laser pumping of highly excited atomic states. 57 refs. (JFP)

57509 Decay of autoionization states in collisions of heavy atomic particles. Ogurtsov, G.N. (Physico-Technical Inst., Leningrad). pp 779-789 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Examples are given showing that autoionization transitions in the quasimolecule can play an important role in ionization processes at low and medium energies of colliding atomic particles. The study of energy spectra of electrons and the x-ray emission spectra make it possible to obtain information on the probability of autoionization transitions in the quasimolecule. Energy levels of helium and argon ions are discussed. 18 refs. (JFP)

57510 Collisionally produced autoionizing and autodetaching states of neutral atoms and their negative ions. Edwards, A.K. (Univ. of Georgia, Athens). pp 790-799 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Experimental procedures and results are discussed for collisionally produced autodetaching states of negative ions and autoionizing states of atoms. Most of the ions and atoms reviewed are those that exist naturally in molecular form and, as such, cannot be readily investigated by electron scattering or positive ion bombardment. 25 refs. (JFP)

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

REFER ALSO TO CITATION(S) 57555

COLLISION PHENOMENA

REFER ALSO TO CITATION(S) 57506, 57509

57511 Crossed molecular beams kinetics: BaO recoil velocity spectra from Ba+N_2O. Parr, T.P.; Freedman, A.; Behrens, R. Jr.; Herm, R.R. (Ames Laboratory-ERDA and Department of Chemistry, Iowa State University, Ames, Iowa 50011). *J. Chem. Phys.;* 67: No. 5, 2181-2190(1 Sep 1977).

Laboratory (LAB) angular and time-of-flight (TOF) recoil velocity spectra of BaO product produced by crossing a thermal Ba beam with an N_2O nozzle beam have been measured in a molecular beam apparatus equipped with an electron bombardment ionizer—quadrupole mass filter "universal" detector. Product center-of-mass (c.m.) recoil angle and energy distributions have been fit to the data by convoluting the c.m. LAB transformation over the measured speed distributions of both beams and the bandpass of the TOF analyzer for different N_2O vibration and relative collision energies. The results indicate a direct reaction mechanism with substantial internal excitation of the products. Backward scattering of the BaO relative to the initial Ba direction is favored, but the product angular distribution also broadens as the reactant energy increases.

57512 Fragmentation of aliphatic chlorocarbons under low-energy (< or approx. =10 eV) electron impact. Johnson, J.P.; Christophorou, L.G.; Carter, J.G. (Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* 67: No. 5, 2196-2215(1 Sep 1977).

The fragmentation of ten aliphatic chlorocarbons ($CHCl_3$, 1,1,1-$C_2H_3Cl_3$, 1,1,2-$C_2H_3Cl_3$, 1,1-$C_2H_4Cl_2$, 1,2-$C_2H_4Cl_2$, C_2Cl_4, C_2HCl_3, 1,1-$C_2H_3Cl_3$, cis-1,2-$C_2H_3Cl_3$, and trans-1,2-$C_2H_3Cl_3$) under low-energy (0—10 eV) electron impact has been investigated with a time-of-flight mass spectrometer. Three types of fragment negative ions were observed: Cl^-, Cl^-_2, and $(M—Cl)^-$ (parent molecule, M, less one Cl atom)$^-$; for C_2Cl_4 the parent ion, $C_2Cl_4^{-*}$, was also observed at ~0. 0 eV and found to be metastable with an autodetachment lifetime of 14 +- 3 μsec. The Cl^- ion was by far the most abundant. The intensities of Cl_2^- and $(M—Cl)^-$ with respect to Cl^- depended very strongly on the number and relative positions of the Cl atoms in the molecule. The yield of Cl_2^- was, as a rule, very much lower when the two Cl atoms in the Cl_2^- ion originated from the same C atom. Distinct resonances were seen whose relative intensity depended strongly on molecular structure. The average positions of the observed resonances are 0.18, 0.54, 0.8, 1.06, and ~1.45 eV for the chloroethanes and 0. 19, 0.53, 0.75, 0.95, and ~1.35 eV for the chloroethylenes. The spacings and energy dependences of the intensities of the observed resonances seem to preclude the involvement of vibrational levels, and the similarity in their positions for the two groups of molecules seems to suggest that they are associated with orbitals dominated by the p-orbitals of the Cl atoms.

The C=C π-orbital is clearly involved in the formation of the long-lived $C_2Cl_4^{-*}$ ion. The relative magnitudes and energy dependences of the Cl^-, Cl_2^-, and $(M—Cl)^-$ ions have been partially rationalized on the basis of the energetics involved in the production of the respective ions. Absolute cross-section values for the Cl^- ions of some of the compounds studied have been obtained.

57513 Long-range interactions of ions with atoms having partially filled p subshells. Gentry, W.R.; Giese, C.F. (Chemical Dynamics Laboratory, Department of Chemistry, University of Minnesota, Minneapolis, Minnesota 55455). *J. Chem. Phys.;* 67: No. 5, 2355-2361(1 Sep 1977).

We derive analytic Born—Oppenheimer potential energy functions, including the charge—quadrupole and charge—induced dipole contributions, for the long-range interaction of a positive or negative ion with an atom having a partially filled p subshell. The charge—quadrupole term vanishes at large separations for the $^2P_{1/2}$ states of p^1 and p^5, the $^3P_0$ state of p^2 and p^4, and all states of p^3. For ^2P and ^3P states the potentials at very large separations are characterized by M/sub J/, and at smaller separations, by M/sub L/. The switchover is controlled by the ratio of the spin—orbit energy to the total anisotropy of the interaction potential. Plots of the positive and negative ion interactions with $C(^3P)$, $O(^3P)$, and $F(^2P)$ are presented as illustrations.

57514 Dynamics of the reaction $D^+{}_2+O(^3P)$ OD^++D, and the influence of the atomic quadrupole moment on the cross section at very low kinetic energies. McClure, D.J.; Douglass, C.H.; Gentry, W.R. (Chemical Dynamics Laboratory, Department of Chemistry, University of Minnesota, Minneapolis, Minnesota 55455). *J. Chem. Phys.;* 67: No. 5, 2362-2370(1 Sep 1977).

We report the results of a merged-beam study of the reaction $D^+{}_2+O(^3P)$ OD^++D over the range of relative kinetic energy from 0.002 to 27 eV. The data include accurate absolute values of the total reaction cross section and also high-resolution measurements of the product ion laboratory energy distributions, which are deconvoluted to obtain estimates of the product energy and angle distributions in c.m. coordinates. The reaction mechanism is direct, with the OD^+ product scattered preferentially in the direction of the incident O atom, and with large average internal excitation. The fact that $O(^3P)$ possesses an electrostatic quadrupole moment has important consequences for the interpretation of the low-energy data in terms of the adiabatic state correlations of reactants, intermediates, and products. Our major conclusions are (1) that the average probabilities of reaction for low-energy capture collisions are about 87% for approaches on Σ^-—A_2 potential energy surfaces and about 53% for approaches on Pi—B_1, B_2 surfaces and (2) that the data are not consistent with the assumption of electronic adiabaticity.

57515 Absolute effective cross sections for the excitation of a strontium atom from metastable states by electron collision. Aleksakhin, I.S.; Shafranosh, I.I. *Opt. Spectrosc. (USSR) (Engl. Transl.);* 42: No. 4, 443(Apr 1977).

Stepwise excitation functions are presented for electron beam-excited energy-level transitions in strontium.(AIP)

57516 Auger transitions in the quasimolecule $Ar^+ + Ar$. Ogurtsov, G.N.; Mikushkin, V.M.; Flaks, I.P. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Tech. Phys. Lett. (Engl. Transl.);* 3: No. 2, 64-65(Feb 1977).

The differential cross sections were measured for the production of Auger electrons in Ar^+-Ar collisions at 4, 5, and 7.5 keV.(AIP)

57517 Physics of electronic and atomic collisions. Risley, J.S.; Geballe, R. (eds.). Seattle; University of Washington Press (1976). 914p. (CONF-750705—). .

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

The conferences included 58 papers. Separate abstracts were prepared for 52 papers. Other papers were outside the scope of ERA. (JFP)

57518 Analysis of electron correlations. Fano, U. (Univ. of Chicago). pp 27-39 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

A review is given of the development of negative ion research. Beginning with the greatest development during the period that of autodetaching states of negative ions through dissociative attachment, production and destruction, ionospheric phenomena, particle accelerators, slow positron collisions in gases, positronium, electron collisions in beams and swarms, to differential and total cross sections, annihilation spectra, and radiation emission. 48 references. (JFP)

57519 Elastic and total scattering of electrons by noble gases. de Heer, F.J. (F.O.M. Instituut voor Atoom- en Molecuulfysica, Amsterdam). pp 79-97 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Experimental results on elastic and total scattering of electrons by noble gases are reviewed which are related to disperison relations. Restriction is made mainly to differential elastic scattering at relatively small angles and total scattering of electrons. 68 references. (JFP)

57520 Measurement of absolute collision cross sections of electrons elastically scattered by gases. Bromberg, J.P. (Carnegie Mellon Inst. of Research, Pittsburgh). pp 98-111 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The measurement of absolute collision cross sections of electrons elastically scattered by gases is reviewed. A brief history, factors to be considered in successful measurement, and some results are presented. Previously unpublished work and a partial bibliography are also included. 18 references. (JFP)

57521 Recent advances in polarized-electron experiments. Kessler, J. (Physikalisches Institut der Universitaet Muenster, Germany). pp 112-125 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The review of polarized-electron experiments includes the production of polarized electrons in various collisions, the Fano effect, and multiphoton ionization. The use of polarized electrons to study exchange collisions and spin polarization in ionization processes is also considered. 34 references. (JFP)

57522 Electron impact excitation of light atoms. McDowell, M.R.C. (Royal Holloway Coll., Surry, Eng.). pp 126-138 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The review of electron impact excitation covers differential, total, and integral cross sections for hydrogen, helium, and alkali metals. 60 references. (JFP)

57523 Inelastic electron-hydrogen atom experiments. Williams, J.F. (Queen's Univ., Belfast). pp 139-150 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Experimental studies of inelastic scattering of electrons from hydrogen atoms are considered from two viewpoints: the determination of absolute cross section values and of radiation polarization and the investigation of scattering phenomena such as resonances, coherent excitation and angular correlations of scattered electrons and photons. 34 references. (JFP)

57524 Theory of low-energy electron-atom collisions and related processes. Bardsley, J.N. (Univ. of Pittsburgh). pp 151-157 of In Physics of electronic and atomic collision. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Some of the ways in which the methods for constructing wave functions for bound states of many atoms and molecules can be adapted or extended to the study of scattering phenomena for low energy electron-atom collisions and related processes are discussed. 17 references. (JFP)

57525 Electron scattering by laser-excited atoms. Hertel, I.V.; Hermann, H.W.; Reiland, W.; Stamatovic, A.; Stoll, W. (Universitaet Kaiserslautern, Ger.). pp 158-175 of In Physics of electronic and atomic collision. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The basic experimental and theoretical methods encountered in the experiment on electron scattering by laser-excited sodium are reviewed, and the difficulties and possibilities of the method are illustrated. This experiment is not complete, however the energy-loss spectra, excitation function for transitions, differential deexcitation

cross sections as a function of the incident light polarization angle, anisotropy of the collision cross section, and the interaction sphere are shown. 19 references. (JFP)

57526 Energy exchanges between two escaping electrons. Read, F.H. (Univ. of Manchester, Eng.). pp 176-193 of In Physics of electronic and atomic collision. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The final-state Coulomb interaction between three or more outgoing charged particles from a reaction can cause exchanges of energy and angular momentum between them. Such exchanges may be present for example when the reaction products consist of two electrons receding from a positive ion. The experimental evidence for the existence of such effects in threshold ionization and threshold autoionization are reviewed, and their possible theoretical descriptions are discussed.

57527 Angular correlation of electrons coming from ionization by electron impact. Paul, D. (Univ. of Toronto); Jung, K.; Schubert, E.; Ehrhardt, H. pp 194-215 of In Physics of electronic and atomic collision. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The experimental work of Ehrhardt and coworkers on the ionization of inert gas atoms by electron impact, in which the full dynamics of the collisions are determined, is reviewed. At the present time no theoretical calculations have been made which will explain all the experimentally observed features of these angular correlations, but the salient features of the ls-ionization can be understood through a comparison with Born, especially Coulomb-projected Born approximations. One can gain insight into some differences between experiment and Coulomb-Born approximations for 2p-electron ionization by comparison with an impulse model, from which it is clear that electron-electron interaction at short range plays a major role in the emission of electrons in the direction of the momentum transfered by the fast electron. Some measurements of the ionization of H_2 and N_2 are briefly discussed.

57528 Theory of low energy electron-molecule scattering. Takayanagi, K. (Univ. of Tokyo). pp 219-230 of In Physics of electronic and atomic collision. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The review of low energy electron-molecule scattering mainly concerns scattering from hydrogen and polar molecules. Also included are distorted-wave, close-coupling, and adiabatic approximations, the interaction potential, rotational excitation by positrons, and vibrational excitations of hydrogen. 54 references. (JFP)

57529 Multiple scattering approach to the vibrational excitation of molecules by slow electrons. Drukarev, G. (Leningrad State Univ.). pp 231-240 of In Physics of electronic and atomic collision. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Another approach to the problem of vibrational excitation of homonuclear two-atomic molecules by slow electrons possibly accompanied by rotational transitions is presented based on the picture of multiple scattering of an electron inside the molecule. The scattering of two fixed centers in the zero range potential model is considered. The results indicate that the multiple scattering determines the order of magnitude of the vibrational excitation cross sections in the energy region under consideration even if the zero range potential model is used. Also the connection between the multiple scattering approach and quasi-stationary molecular ion picture is established. 9 refs. (JFP)

57530 Classification of Feshbach resonances in electron-molecule scattering. Spence, D. (Argonne National Lab., IL). pp 241-255 of In Physics of electronic and atomic collision. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Certain systematics are derived which often enable a simple determination of resonance configurations in electron-molecule scattering by making a comparison between resonance spectra and known Rydberg-state spectra. The determination of resonance grandparent states and the systematics of the binding energies of pairs of Rydberg electrons in diatomic molecules, the systematics of the binding energies of electrons with various values of n and l to parent Rydberg states, and an application of guidelines provided by the above systematics to new systems are treated. 19 refs. (JFP)

57531 Progress in the quantum dynamics of reactive molecular collisions. Kuppermann, A. (California Inst. of Tech., Pasadena). pp 259-274 of In Physics of electronic and atomic collision. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Progress in accurate quantum mechanical calculations of reactive collisions is reviewed. The results of three-dimensional calculations are described and compared with those of approximate methods. Resonances in reactive scattering are discussed as well as electronically nonadiabatic chemical reactions.

57532 Non-adiabatic effects in collisional vibrational relaxation of diatomic molecules. Nikitin, E.E. (Inst. of Chemical Physics, Moscow). pp 275-292 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

A review is given of the present status of the problem of nonadiabatic effects in collisional vibrational relaxation of diatomic molecules with restriction to 0 1 or 1 0 vibrational transition thus disregarding all effects connected with multiquantum jumps. The semiclassical interpretation is used. Electronically adiabatic and nonadiabatic vibrational to rotational and translational energy exchange, and some representative processes are discussed. 42 refs. (JFP)

57533 Some aspects of the molecular approach to atomic collisions. Sidis, V. (Universite de Paris Sud, Orsay, France). pp 295-312 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Beginning with the formal analogy between an atom-atom collision system and a diatomic molecule and nuclear velocity and spatial extension of the nuclear motion the treatment proceeds to simple examples of basis set choices, adiabatic states having the same symmetry and adiabatic states having underlying different symmetry. 68 refs. (JFP)

57534 Optical emission in slow atomic collisions. Kempter, V. (Fakultaet fuer Physik der Universitaet Freiburg). pp 327-344 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

It was attempted to point out the different possibilities to obtain information on excitation mechanisms for electronic excitation in slow atomic collisions by means of optical methods. Particular attention was paid to measurements of excitation cross sections in the threshold region, to high resolution studies allowing the separation of the multiplet components, and to measurements of the total and differential polarisation.

57535 Electron ejection in slow heavy particle collisions. Morgenstern, R. (Fakultaet fuer Physik der Universitaet Freiburg). pp 345-358 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Investigations of ionizing ion—atom and atom—atom collisions by means of electron analysis is described. The collision energies range up to several keV. Included are electrons due to atomic autoionization, autoionization of quasimolecules, and coincidence measurements and collisionally induced alignment. 56 refs. (JFP)

57536 Experimental studies of inner-shell excitation in slow ion-atom collisions. Fastrup, B. (Univ. of Aarhus, Denmark). pp 361-383 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Experimental data which may illustrate various inner-shell excitation mechanisms in slow ion—atom collisions are discussed which were published since 1972 and 1973. Experimental techniques are also considered. 57 refs. (JFP)

57537 Theory of inner-shell excitation in slow ion-atom collisions. Briggs, J.S. pp 384-407 of In Physics of electronic and atomic

collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Progress made in the calculation of cross sections for excitation of inner-shell electrons in slow collisions of ions with atoms is reviewed. These cross sections were calculated by means of the time-dependent Schroedinger equation using an approximate solution by expansion in a finite set of independent-electron molecular orbitals. Restriction is made to the nonrelativistic regime. 50 refs. (JFP)

57538 Experimental studies of target and projectile X radiation in high velocity atomic collisions. Macdonald, J.R. (Kansas State Univ., Manhattan). pp 408-418 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

A review is given of experimental research on x radiation in high velocity atom collisions. Included are inner-shell ionization, total ionization cross sections, heavy-ion collisions, and electron promotion processes. 22 refs. (JFP)

57539 Study of K, L, and M inner-shell ionization by proton impact. Nikolaev, V.S.; Petukhov, V.P.; Romanovsky, E.A.; Sergeev, V.A.; Kruglova, I.M.; Beloshitsky, V.V. (Moscow State Univ.). pp 419-431 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The total cross sections for ionization of the K, L, and M shells with electron binding energy I = 2 to 10 keV by protons with energy E = 150 to 500 keV, and the ratios of the ionization cross sections for the L_1 and L_2 subshells of Pd, Sb, and La atoms with electron binding energy of about 4 keV were studied. Also calculations of the ionization cross sections for the ejection of electrons from the various states of the K, L, and M shells were made in the Born approximation and the connection of the specific features in the ratio of the ionization cross sections with the peculiarities of the electron initial states was analyzed. 34 refs. (JFP)

57540 Impact parameter dependence of inner shell excitation. Lutz, H.O. (Univ. of Bielefeld, Germany). pp 432-446 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Recent developments in the area of inner-shell excitation using coincidence experiments are reviewed. Restriction is made to target atoms heavier than hydrogen or helium. 35 refs. (JFP)

57541 High-resolution x-ray and Auger electron measurements in ion-atom collisions. Moore, C.F. (Univ. of Texas, Austin). pp 447-469 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Material presented in the last few years on ion-atom collision phenomena is summarized. Many different aspects of the ion-atom interaction are discussed. Work on collisions where both projectile and target have Z greater than 1 is stressed.

57542 Experimental evidence for anisotropy of non-characteristic x-rays. Mokler, P.H.; Armbruster, P.; Folkmann, F.; Hagmann, S.; Kraft, G.; Stein, H.J. (Universitaet zu Koeln, Darmstadt, Germany). pp 501-519 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

A report is given of how well the shape and absolute cross section of experimentally measured molecular-orbital x-ray spectra is understood. Emphasis is placed on noncharacteristic K radiation from heavy ion collisions. This survey of presently available K-x-ray data of molecular origin particularly ion-gold collisions has yielded a surprisingly good agreement between the experimental results and the two-collision theory. 29 refs. (JFP)

57543 Radiative and nonradiative electron capture from and into outer and inner shells in heavy ion-atom collisions. Betz, H.D.; Kleber, M.; Spindler, E.; Bell, F.; Panke, H.; Stehling, W. (Universitaet Muenchen). pp 520-530 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Nonradiative electron capture processes are discussed, based on the first Born approximation and adopted for use in heavy ion collisions. Competition of electron capture with direct target ionization and with other decays of projectile vacancies is indicated. Radiative electron capture (REC) is described theoretically; experimental REC spectra are shown along with calculated spectra. Discrepancies between experiment and theory are discussed and one comments on the possibility to use REC measurements to infer momentum distributions of target electrons.

57544 Photodetachment threshold processes. Lineberger, W.C. (Univ. of Colorado, Boulder). pp 584-592 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

A brief summary is given of threshold laws for the case in which a ground state neutral atom or molecule is produced in the photodetachment process. Also the cases in which the resulting atom is left in an excited state and the two-electron ejection threshold resulting in a positive ion are examined. 14 refs. (JFP)

57545 Multiphoton processes with polarized light. Lambropoulos, P. (Texas A and M Univ., College Station). pp 593-608 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

A selected number of topics on multiphoton ionization processes with polarized light are reviewed. Emphasis is placed on problems that are being actively pursued at the present time. Restriction is made to the essential aspects of the process under consideration without entering into theoretical or experimental details. Processes which can be understood within the framework of radiation perturbation theory including corrections for shifts and widths induced by the laser are considered. Spin-orbit coupling, optical pumping, and electric quadrupole contributions are discussed. 48 refs. (JFP)

57546 Analysis of inelastic electron—photon coincidence experiments. Kleinpoppen, H.; Blum, K.; Standage, M.D. (Univ. of Stirling, Scotland). pp 627-659 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Alignnment and orientation in atomic collisions are reviewed. Recent techniques which examine impact radiation under conditions where the geometry has a lower degree of symmetry are discussed, including polarization and coincident radiation. 22 refs. (JFP)

57547 Glauber and Glauber-related methods in atomic physics. Byron, F.W. Jr. (Univ. of Masachusetts, Amherst). pp 675-684 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

A brief summary of recent developments in the field of Glauber and Glauber-related approximations is presented. The use and difficulties, cross sections, elastic scattering, scattering amplitudes, differential cross sections, polarization potential, and optical potential method are presented. 21 refs. (JFP)

57548 Variational principles, subsidiary extremum principles, and variational bounds. Spruch, L. (New York Univ.). pp 685-698 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Ignoring many details, and studiously avoiding the temptation to state results in their most general context, one reviews some very recent developments in the construction and use of variational principles (V Ps), variational bounds (V Bds), and related techniques. These developments include: an approach that enables one to construct a V P for almost any well posed problem in mathematical physics by the use of a Lagrange undetermined multiplier (which can be a constant λ, a function L, an operator Λ, . . .) to account for each constraint; subsidiary extremum principles which provide a very useful means for the approximate determination of such multi-

pliers; variational identities; upper and lower V Bds on relatively arbitrary bound state matrix elements; an upper V Bd on the scattering length A when the target ground state wave function phi and energy ϵ_1 are only imprecisely known; and a lower V Bd on A which uses the adiabatic approximation.

57549 Ionization of highly excited atoms by atomic particle impact. Smirnov, B.M. (Inst. of Atomic Energy, Moscow). pp 701-711 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The ionization of a highly excited atom by a collision with an atom or molecule is considered. The theory of these processes is presented and compared with experimental data. Cross sections and ionization potential are discussed. 23 refs. (JFP)

57550 (e,2e) reaction. McCarthy, I.E. (Flinders Univ. of South Australia, Bedford Park). pp 766-778 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The (e,2e) reaction is studied in experiments designed to observe the properties of valence electrons in gas targets. Noncoplanar symmetric experiments are discussed. The examples of the Argon ion, the methane molecule, and the helium ion states are considered. 12 refs. (JFP)

57551 Study of momentum transfer distributions in rotationally inelastic collisions. Bischel, W.K.; Rhodes, C.K. (Univ. of California, Livermore). pp 820-829 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

An experimental technique is presented utilizing the methods of laser saturation spectroscopy that enables a direct observation of the momentum transfer distribution generated by rotationally inelastic molecular collisions. This method has been applied to CO_2 in collision with a wide variety of partners including He, H_2, CO_2, CH_3F, and Kr. The observations indicate that in a large number of cases the rotational transition results primarily from peripheral collisions which are effective in transferring angular momentum, but which communicate a relatively small linear momentum transfer.

ATOMIC AND MOLECULAR THEORY

57552 Quantum versus classical dynamics in the treatment of multiple photon excitation of the anharmonic oscillator. Walker, R.B.; Preston, R.K. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* 67: No. 5, 2017-2028(1 Sep 1977).

The response of a one-dimensional anharmonic Morse oscillator to an intense electromagnetic field has been investigated using both a quasiclassical and quantum mechanical description of the oscillator. The anharmonic nature of the Morse potential reduces the coherence of the quantum excitation process after only a few quanta have been absorbed. The classical and quantum behavior of averaged quantities such as the energy absorbed and the oscillator displacement as a function of time are in good agreement; however, the classical description cannot reproduce the multiphoton resonances. We are led to the conclusion that classical mechanics provides an adequate description of the response of a molecule in an intense laser field provided that multiphoton resonances do not individually play a fundamental role in the process.

57553 X-ray diffraction pattern and models of liquid benzene. Narten, A.H. (Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* 67: No. 5, 2102-2108(1 Sep 1977).

X-ray diffraction data for liquid benzene at 25°C are analyzed using scattering factors for C—H groups rather than for C and H atoms. This new approach permits the unique extraction of structure and correlation functions for carbon—carbon interactions from a single experiment. The data are used to find parameters for a model (RISM) of liquid benzene which permits calculation of all intermolecular atom pair correlation functions. The predominant arrangement in the liquid is one in which pairs of molecules fit together like six-toothed bevel gear wheels whose axes are almost at right angles.

57554 SCF-stabilization approach to excited states embedded in the continuum. Bender, C.F.; McKoy, V.; Davidson, E.R. (Theoretical Atomic and Molecular Physics Group, Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Chem. Phys.;* 67: No. 5, 2178-2180(1 Sep 1977).

By using SCF and stabilization-like procedures, we have located a (π, π^*) singlet resonance-like state in ethylene at 10.21 eV. This state is embedded in the ionization continuum and carries an oscillator strength of 0.46, and is probably the analog to the spectroscopic V state in Hartree—Fock theory. Implications of these results for other systems are discussed.

57555 Negative ions, positive electrons. Massey, H. (University Coll., London). pp 3-26 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The review of negative ions and positive electrons includes autodetaching states, production and destruction of negative ions, total cross sections, collisions, and positronium. 45 references. (JFP)

57556 Parity violation in atoms due to neutral weak currents. Henley, E.M. pp 50-61 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The discussion of parity violation in atoms due to neutral weak current includes the basic Weinberg framework and the detection of atomic parity violation in various possible experiments. 19 references. (JFP)

57557 Important problems in future heavy ion atomic physics. Betz, W.; Heiligenthal, G.; Reinhardt, J.; Smith, R.K; Greiner, W. (Universitaet Frankfurt am Main). pp 531-559 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Among the important problems in heavy ion atomic physics are the decay of the neutral vacuum, possible spectroscopy of intermediate superheavy molecules, and atomic physics at relativistic ion energies. 49 refs. (JFP)

57558 Atomic physics with synchrotron radiation. Madden, R.P. (National Bureau of Standards, Washington, DC). pp 563-583 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The contributions made in atomic physics through the use of synchrotron radiation sources are reviewed. Included are atomic photoabsorption, photoelectron spectroscopy, fluorescence, mass spectroscopy, and the use of circular polarization. 28 refs. (JFP)

57559 Resonances seen in secondary electron spectra. Mehlhorn, W. (Universitaet Frieburg). pp 756-765 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The shape and intensity of resonances seen in secondary electron spectra as well as correlation effects in the decay process of Auger states are treated. 12 refs. (JFP)

GENERAL FLUID DYNAMICS

57560 (COO—3077-145) Survey of numerical methods for compressible fluids. Sod, G.A. (New York Univ., N.Y. (USA). Courant Inst. of Mathematical Sciences). Jun 1977. Contract EY-76-C-02-3077. 67p. Dep. NTIS, PC A04/MF A01.

The finite difference methods of Godunov, Hyman, Lax-Wendroff (two-step), MacCormack, Rusanov, the upwind scheme, the hybrid scheme of Harten and Zwas, the antidiffusion method of Boris and Book, and the artificial compression method of Harten are compared with the random choice known as Glimm's method. The methods are used to integrate the one-dimensional equations of gas dynamics for an inviscid fluid. The results are compared and demonstrate that Glimm's method has several advantages. 16 figs., 4 tables.

SUPERFLUIDITY

57561 Fluctuational character of phase transition development in liquid helium. Smirnov, A.P. (A. F. Ioffe Physicotechnical Institute,

Academy of Sciences of the USSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* 3: No. 1, 60-61(Jan 1977).

The temperature dependences of the relative normal fluid density rho/sub n//rho of liquid helium at low temperatures and of the superfluid to normal-fluid density ratio rho/sub s//rho/sub n/ at higher temperatures have been analyzed similarly to the analysis of the superconducting transition in mercury threads. It is shown that the temperature range 0.8—4°K can be treated as a fluctuation-smeared phase transition in liquid helium (to the superfluid state) proceeding, similarly to superconductors, in three stages with characteristic temperatures T/sub c1/=1.4°K and T/sub c0/ =T_1=2.172°K separating regions with exponential temperature dependences of rho/sub n//rho and rho/sub s//rho/sub n/.

HIGH ENERGY PHYSICS

REFER ALSO TO CITATION(S) 57089

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 57568

57562 Photoproduction of neutral pions from hydrogen at 320 MeV. Aleksandrov, Y.A.; Kozlov, V.A.; Maikov, V.N.; Pavlovskaya, V.V. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* 25: No. 1, 43-45(Jan 1977).

Differential cross sections for neutral-pion photoproduction from hydrogen are obtained at 320 MeV and pion c.m.s. angles 10, 30, 60, 90, and 120 degrees.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 57596

57563 Scaling-variable distributions for antineutrino-nucleon interactions. (I 1315+g). *Phys. Rev. Lett.;* 39: No. 7, 382-385(15 Aug 1977).

New data are reported on high-energy antineutrino interactions obtained using the Fermilab 15-ft bubble chamber filled with a light neon-hydrogen mixture. The new data support a gentle energy dependence for the y distribution consistent with the trend of the existing data, but show no evidence for a marked energy threshold. The data for <x< and <v< = <xy< show some decrease with increasing energy which may be related to scaling deviations measured in electron and muon experiments.

57564 Inclusive γp and γn charged-current neutrino reactions below 6 GeV. Barish, S.J.; Derrick, M.; Dombeck, T.; Hyman, L.G.; Musgrave, B.; Schreiner, P.; Singer, R.; Szcekowski, M. (Argonne National Lab., Ill. (USA)); Barnes, V.E.; Carmony, D.D. *Phys. Lett., B;* 66: No. 3, 291-294(31 Jan 1977).

Results are presented of a study of inclusive γp and γn interactions from threshold to 6 GeV. The data show a rapid approach to the distributions expected in the naive quark-parton model. The charged-current γ deuteron total cross section is fit by the expression sigmasub(T)(γd)=(0.76+-0.03)x10^{-38} Esub(γ)cm^2 per GeV per nucleon. For Esub(γ)<1.5 GeV, the authors measure sigmasub(T)(γn)/sigmasub(T)(γp)=(2.02+-0.23). The distributions in the scaling variables x and y are given and discussed.

57565 Results of the search for the intermediate W boson in proton-nucleus collisions at 70 GeV. Abramov, V.V.; Anisimova, N.Z.; Bondarenko, G.B.; Gridasov, V.I.; Dobretsov, Y.P.; Dolgoshein, B.A.; Dyshkant, A.S.; Kalinovskii, A.N.; Kantserov, V.A.; Kirillov-Ugryumov, V.G.; Kiselev, A.V.; Nevskii, P.L.; Nikitin, Y.P.; Rodnov, Y.V.; Rozhnov, G.V.; Sapunov, Y.M.; Somov, S.V.; Sulyaev, R.M. (Institute of High Energy Physics, Serpukhov). *Sov. J. Nucl. Phys. (Engl. Transl.);* 25: No. 1, 41-43(Jan 1977).

Direct muon yields were measured in the range 1.9<p/sub perpendicular/<3.1 GeV/c in order to detect the W boson produced in proton-nucleus collisions. Comparison of the experimental data with calculations indicates that there is no W boson in the mass interval 5.5—8.5 GeV/c^2.

STRONG BARYON-INDUCED INTERACTIONS

57566 Comparison of the line-reversed channels p-barp $\pi^-\pi^+$ and π^+p $p\pi^+$ at 6 GeV/c. Stein, N.A.; Edelstein, R.M.; Green, D.R.; Halpern, H.J.; Makuchowski, E.J.; Russ, J.S.; Weintraub, D.M.; Bar-Yam, Z.; Dowd, J.P.; Kern, W.; Russell, J.J.; Sharfman, N.; Singer, M.N. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev. Lett.;* 39: No. 7, 378-381(15 Aug 1977).

Differential cross sections have been measured for p-barp $\pi^-\pi^+$ (1) and its line-reversed partner π^+p $p\pi^+$ (2) in the range t/sub min/ < t < - 1.5 $(GeV/c)^2$ at 6 GeV/c. Clear structure is seen in the differential cross section for Reaction (1) at t ~ - 0.4 $(GeV/c)^2$. However, this feature is quite different from the striking dip seen in (2) at t ~ - 0.15 $(GeV/c)^2$, this difference indicating a failure of line reversal and disagreement with simple Regge models.

STRONG MESON-INDUCED INTERACTIONS

57567 Measurement of the π^+p and π^-p polarization parameters at 100 GeV/c. Auer, I.P.; Hill, D.; Sandler, B.; Yokosawa, A.; Brueckner, W.; Chamberlain, O.; Steiner, H.; Shapiro, G.; Jonckheere, A.; Koehler, P.F.M.; Kline, R.V.; Law, M.E.; Pipkin, F.M.; Johnson, W.; Snyder, J.; Zeller, M.E. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* 39: No. 6, 313-316(8 Aug 1977).

We report measurements of the polarization parameters in π^+p and π^-p elastic scattering at an incident momentum of 100 GeV/c. The results cover the range 0.18 < or = -t < or = 1.4 GeV^2 and are in agreement with current Regge-model predictions.

57568 From the psi to charm: the experiments of 1975 and 1976. Richter, B. (Stanford Univ., CA). *Science;* 196: No. 4296, 1286-1297(17 Jun 1977).

The review of physics research starting with the discovery of the psi particle includes the electron—positron colliding beam technique, early results, properties and decays of the psi, intermediate states in psi decay, total cross sections and broader states, theory, and the observation of jets. 36 references. (JFP)

57569 Elastic π^+p, K^+p, and pp scattering in the region of Coulomb-nuclear interference at momenta 42.5 and 52.2 GeV/c. Akopin, V.D.; Vasil'ev, A.N.; Derevshchikov, A.A.; Matulenko, Y.A.; Meshchanin, A.P.; Mysnik, A.I.; Nurushev, S.B.; Saraikin, A.I.; Siksin, V.V.; Smirnov, E.V.; Solov'ev, L.F.; Solov'yanov, V.L. (Institute of High Energy Physics, Serpukhov). *Sov. J. Nucl. Phys. (Engl. Transl.);* 25: No. 1, 51-55(Jan 1977).

We measured the differential cross sections for elastic scattering of positive pions, kaons, and protons by protons, and also the total cross sections at incident momenta 42.5 and 52.2 GeV/c. The squares of the 4-momentum transfer ranged from 10^{-3} to 5 x 10^{-2} $(GeV/c)^2$. The experimental data were used to determine the ratio rho(0) of the real part of the forward elastic-scattering amplitude to the imaginary part. The results are compared with the dispersion relations.

57570 Two-particle correlations of charged particles and γ rays in π^-n interactions at momentum 40 GeV/c. Angelov, N.; Vishnevskaya, K.P.; Grishin, V.G.; Dzhmukhadze, S.V.; Didenko, L.A.; Ivanovskaya, I.A.; Inogamova, T.Y.; Kanarek, T.; Kladnitskaya, E.N.; Lyubimov, V.B.; Lyutov, S.I.; Mel'nikova, N.N.; Nazargulov, R.M.; Nikitina, V.F.; Popova, V.M.; Solomin, A.N.; Semerdzhiev, K.I.; Solov'ev, M.I.; Tuvdendorzh, D.; Fadeev, N.G.; Tsivtsivadze, E.T.; Shcheglova, L.M.; Shklovskaya, A.I. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* 25: No. 1, 60-62(Jan 1977).

Experimental data are presented on the investigation of two-particle rapidity correlations $R(y_1^*, y_2^*$ and C (y_1^*, y_2^*) for (ch, ch), and (γ,γ) systems in π-n interactions at a momentum of 40 GeV/c. The values of the functions R and C are obtained for (γ, π-) and γ,π+) systems. An analysis of the experimental data has shown that short-range positive correlations are observed for the (ch, ch), (γ, ch), and (γ, γ) systems.

57571 Investigation of rho^0- and ω-meson production in π^-p interactions at 40 GeV/c. Angelov, N.; Akhababyan, N.O.; Vishnevskaya, K.P.; Grekova, L.D.; Grishin, V.G.; Dzhmukhadze, S.V.; Didenko, L.A.; Ivanovskaya, I.A.; Ikov, N.L.; Inogamova, T.Y.; Kanarek, T.; Kopylov, G.I.; Kladnitskaya, E.N.; Lyubimov, V.B.; Lyutov, S.I.; Mel'nikova, N.N.; Murzin, V.S.; Nazargulov, R.M.; Nikitina, V.F.; Penev, V.N.; Popova, V.M.; Solomin, A.N.; Semerdzhiev, K.I.; Solov'ev, M.I.; Tuvdendorzh, D.; Fadeev, N.G.; Khristov, K.Y.; Tsivtsivadze, E.T.; Shklovskaya, A.I.; Shcheglova, L.M. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* 25: No. 1, 63-66(Jan 1977).

The cross sections for rho^0- and ω-meson production in inclusive and semi-inclusive π^-p reactions at the momentum 40 GeV/c are obtained.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 57558

57572 Polarization characteristics of coherent bremsstrahlung with off-axis collimation. Kuznetsov, V.M.; Potylitsin, A.P.; Stukov, O.I. (Institute of Nuclear Physics, Electronics, and Automation at the Tomsk Polytechnic Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 73-77(Jan 1977).

The Stokes parameters of coherent bremsstrahlung from a thin single-crystal target, with off-axis collimation, are calculated in the Born approximation. It is shown that the polarization of the γ beam increases appreciably in comparison with axial collimation. The azimuthal dependence of the radiation is considered, and it is demonstrated that it can be used to determine the maximum-polarization plane.

57573 Radiative transitions in the charmonium model. Vysotskii, M.I. (Moscow Physico-Technical Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 77-79(Jan 1977).

Radiative decays of the psi'-meson are discussed: psi' ychi $\gamma\gamma$ypsi. The results allow one to compare the predictions of the model with the experimental data.

WEAK INTERACTIONS

57574 Deep-inelastic scattering of leptons by virtual particles. Volkonskii, N.Y.; Novozhilov, V.Y.; Prokhorov, L.V.; Solov'ev, V.F. (Leningrad State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 79-83(Jan 1977).

We consider the possibility of extracting the structure functions of the pion and rho meson from the process of deep-inelastic lepton-proton scattering with a low-energy nucleon detected in the final state. The allowed kinematic region in Q^2 and in the momentum transferred to the hadron, corresponding to deep-inelastic scattering by virtual π and rho mesons, is determined. Since information on the structure functions F/sub 1,2/(x/ of the nucleon can apparently be extracted from experimental data also in the region where scaling is violated (Volkonskii and Prokhorov, 1975) (Q^2=0.1—1.5 GeV^2), it is indicated that such an extension of the allowed region can yield reasonable statistics for events that contain information on the structure functions of the pion.

57575 Effects of neutral currents in the process of e^+e^- annihilation into a baryon-antibaryon pair. Khristova, E.K. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 84-86(Jan 1977).

An analysis is made of P-odd effects in the process e^+e^- BB-bar with longitudinally polarized e^+ and e^-, assuming the existence of weak neutral currents. Estimates of these effects in the process e^+e^- pp-bar are obtained in the Weinberg model. The possibility of isolating an axial isoscalar in the reaction e^+e^- $\Lambda^0\Lambda^0$ is pointed out.

57576 Weak interaction of colored hadrons. Arbuzov, B.A.; Rochev, V.E.; Tikhonin, F.F. (Institute for High Energy Physics, Serpukhov). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 87-91(Jan 1977).

The most general form of the weak hadronic current in the colored quark model is analyzed under the assumption that the algebra of weak charges is closed. A direct consequence of this assumption is the absence of off-diagonal neutral currents. The nonvanishing components of the neutral current are identical to the components of the electric charge. This makes it possible to construct the electromagnetic current as a sum of left-handed and right-handed weak currents. The general expression for the current obtained in this manner depends on eight parameters; however, most of the known physical requirements can be satisfied by using two angles analogous to the Cabibbo angle. If one requires that exotic transitions be forbidden, one can obtain a value sinθ/sub C/=0.211 for the Cabibbo angle. A method of construction of currents is indicated which can be applied to any theory with a symmetry of the color type.

57577 Polarization phenomena in isobar production by a weak neutral current. Esaibegyan, S.V.; Matinyan, S.G. (Erevan Physics Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 92-95(Jan 1977).

We consider weak-neutral-current polarization effects that lead to production of an isobar in lepton-nucleon scattering. We show that measurement of the pion angular distribution in an experimental setup in which the longitudinally polarized decay nucleon is also measured can yield useful information on the validity of various models that include weak neutral currents.

STRONG INTERACTIONS, GENERAL

57578 Three-body mechanism for narrow resonances. Brayshaw, D.D. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **39**: No. 7, 371-374(15 Aug 1977).

A new three-body mechanism is proposed, which leads naturally to narrow states at energies easily calculable via a simple analytic formula. The (zero-parameter) formula predicts over a score of narrow resonances in remarkable coincidence with experiment.

57579 Non-Abelian gauge fields and nonrelativistic bound states. Feinberg, F.L. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev. Lett.;* **39**: No. 6, 316-319(8 Aug 1977).

The second-quantized Coulomb-gauge Hamiltonian for any nonrelativistic system of fermions minimally coupled to non-Abelian gauge fields is derived by performing successive non-Abelian Foldy-Wouthuysen transformations. In this general formalism, a detailed analysis is made of threshold fermion-antifermion bound states in the weak-coupling limit and the form of the two-loop nonrelativistic Bethe-Salpeter kernel is determined. This kernel gives a static potential independent of the fermion mass, but only for singlet states of the gauge group.

STRONG INTERACTIONS, BARYON NO.=0

REFER ALSO TO CITATION(S) 57568, 57619

57580 Unified description of the processes $\pi\pi$ $\pi\pi$ and $\pi\pi$ KK-bar. Vall, A.N.; Kaloshin, A.E.; Parfenov, Y.V.; Henner, V.K. (Irkutsk State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 110-112(Jan 1977).

The amplitudes of the processes $\pi\pi$ $\pi\pi$ and $\pi\pi$ KK-bar in a state with isospin I=0 are described in unified manner within the framework of a simple model based on dispersion relations. The effect of opening the KK-bar channel on the $\pi\pi$-scattering amplitude is discussed.

STRONG INTERACTIONS, BARYON NO.=1

REFER ALSO TO CITATION(S) 57619

57581 Elastic πN scattering in a dual model with the correct spectrum of baryon resonances. Iroshnikov, G.S. (Moscow Physicotechnical Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 95-99(Jan 1977).

A dual model for the πN scattering amplitude without parity doubling in the spectrum of baryon resonances on the four leading trajectories is proposed. The structure of the baryon-exchange Feynman graphs is used as a guide in constructing the model. On the whole, the theoretical predictions of the model are in good agreement with the spectrum and elastic widths of the experimentally observed particles.

57582 Early scaling and exotic channels in πN interactions in the fragmentation regions. Jancso, G. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 99-102(Jan 1977).

Experimental data on π^-p and π^-n interactions at 40 GeV/c are used to obtain evidence for early scaling in the π^- /sup N/π^+ fragmentation region. The comparison of these results with other data leads to a number of conditions for the presence of early scaling in the fragmentation regions. A dual model can be used to obtain experimental information about the relative contributions of the various dual diagrams. The isotopic invariance of inclusive πN reactions is also considered. It is shown that isotopically conjugate reactions have similar features.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

57583 Double scattering in deuterium as a probe of hadron structure. Baker, M.; Lubatti, H.J.; Rogers, E.O.; Weis, J.H. (Department of Physics, University of Washington, Seattle, Washington 98195). *Phys. Rev. Lett.;* **39**: No. 7, 375-378(15 Aug 1977).

Comparing hadron-deuteron and hadron-hadron data for various energies and reactions, we study the time development of hadronic matter and in particular test the Abramovskii-Gribov-Kancheli rules.

57584 Production of ultrafast pions in collisions of relativistic deuterons with protons and nuclei. Lobov, G.A.; Markushin, V.E.; Solov'ev, V.V.; Shapiro, I.S. (Institute of Theoretical and Experimental Physics, State Atomic Energy Commission). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 102-109(Jan 1977).

The production of high-energy pions is considered in the impulse approximation. Effects of relativization of the deuteron

wave function are investigated. It is shown that the experimental data on the inclusive production of ultrafast pions on nuclei can be explained within the framework of the conventional concepts concerning the deuteron structure. Possible modifications of the model, aimed at improving the agreement between theory and the experimental data, are considered, as are also additional experiments needed for an unambiguous identification of the mechanism of the considered processes.

57585 Contributions to the theory of isobar knockout from a deuteron. Kolybasov, V.M. (Institute of Theoretical and Experimental Physics, State Atomic Energy Commission). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 112-117(Jan 1977).

To identify the pole mechanisms responsible for the knockout of an isobar from a deuteron, it is proposed to use a program developed earlier for ordinary knockout reactions (Kolybasov et al., 1974). Greatest attention is paid to the distribution in the Treiman-Yang angle and to polarization effects. It is indicated that the asymmetry coefficient in the angular distribution of the spectator-isobar decay products has a characteristic dependence on the momentum of this isobar. In the case when spin effects play a significant role in the elastic scattering of the incident particle by the isobar, a connection is established between the form of the distribution in the Treiman-Yang angle and the form of the angular distribution of the spectator-isobar decay products.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 57556

APPLICATIONS TO STRONG INTERACTIONS

57586 Intermultiplet mixing of the vector mesons in a nonperturbative approach to broken SU(4). Slaughter, M.D.; Oneda, S. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **39**: No. 6, 309-312(8 Aug 1977).

We predict the mass spectrum of the 2^3S_1, J/sup P C/ = 1^{--} vector mesons, the D^*-$D^{*'}$ mixing angle, and the F^*-$F^{*'}$ mixing angle (defined to be equal to the D^*-$D^{*'}$ mixing angle) in a nonperturbative approach to broken SU(4) symmetry.

FIELD THEORY

REFER ALSO TO CITATION(S) 57557

57587 Radiative corrections to the classical Lagrangian and dynamical symmetry breaking. Matinyan, S.G.; Savvidi, G.K. (Erevan Physics Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 118-122(Jan 1977).

A method for making an exact calculation of the effective action Γ in the single-loop approximation is proposed. A direct summation of the single-loop diagrams with closed fermion loops in quantum electrodynamics leads to the well known Heisenberg-Euler Lagrangian. Similar calculations are carried out in the phi^4 theory, for which it is possible to calculate the exact single-loop Lagrangian in two cases: a constant field and a plane-wave field. The results are used to discuss problems connected with dynamical symmetry breaking.

PHYSICS RESEARCH (CONT.)

NUCLEAR PHYSICS

57588 (BNL-NCS—50545(Vol.1)) **ENDF/B fission product decay data.** Rose, P.F.; Burrows, T.W. (Brookhaven National Lab., Upton, N.Y. (USA)). Aug 1976. Contract EY-76-C-02-0016. vp. (ENDF—243(Vol.1)). Dep. NTIS, PC A19/MF A01.

The fission product data have been organized by A-chains in order of ascending A from A = 72 to A = 167. The heading page is followed by more detailed information on the individual members of the chain in order of increasing Z and decreasing metastable state. The detailed information for each member includes the ENDF/B-IV File 1 comments and references if available and applicable to the decay data. Following the comments is a decay scheme of the nuclide tabulating the quantities T/sub ½/, Q, branching ratio (BR), (E/sub γ/), (E/sub β/), and (E/sub α/). Uncertainties are given if available in the file. Independent fission yields are given, as well as thermal cross sections and resonance integrals as obtained from ENDF/B-IV. All energies listed in this publication are in keV, and all branching ratios sum to unity. If there are spectra in the decay data file, the decay scheme is followed by tables of photon, particle, and characteristic radiation. For cases in which the multipolarities could be obtained from the file the tables also contain information on x rays, conversion electrons, and Auger electrons. Associated with the photon and particle radiation tables are the appropriate average energies per decay for each type of radiation, including neutrino radiation.

57589 (BNL-NCS—50545(Vol.2)) **ENDF/B fission product decay data.** Rose, P.F.; Burrows, T.W. (Brookhaven National Lab., Upton, N.Y. (USA)). Aug 1976. Contract EY-76-C-02-0016. vp. (ENDF—243(Vol.2)). Dep. NTIS, PC A19/MF A01.

The fission product data have been organized by A-chains in order of ascending A from A = 72 to A = 167. The heading page is followed by more detailed information on the individual members of the chain in order of increasing Z and decreasing metastable state. The detailed information for each member includes the ENDF/B-IV File 1 comments and references if available and applicable to the decay data. Following the comments is a decay scheme of the nuclide tabulating the quantities T/sub ½/, Q, branching ratio (BR), (E/sub γ/), (E/sub β/), and (E/sub α/). Uncertainties are given if available in the file. Independent fission yields are given, as well as thermal cross sections and resonance integrals as obtained from ENDF/B-IV. All energies listed in this publication are in keV, and all branching ratios (BR) sum to unity. If there are spectra in the decay data file, the decay scheme is followed by tables of photon, particle, and characteristic radiation. For cases in which the multipolarities could be obtained from the file the tables also contain information on x-rays, conversion electrons, and Auger electrons. Associated with the photon and particle radiation tables are the appropriate average energies per decay for each type of radiation, including neutrino radiation.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

57590 Singlet even nucleon-nucleon potentials obtained by an algebraic method for the inverse problem of scattering theory. Malyarov, V.V.; Poplavskii, I.V.; Popushoi, M.N. (Odessa Engineering and Construction Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 38-40(Jan 1977).

The singlet even nucleon-nucleon potentials at fixed energy values from 60 to 120 MeV (with 10-MeV intervals) in the c.m.s. are reconstructed from the phase shifts using the algebraic method for the inverse problem of scattering theory in the complex λ plane. An analysis of the obtained results is presented.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

57591 (ANL/NDM—33) **Comments on the energy-averaged total neutron cross sections of structural materials in the few MeV range.** Smith, A.; Whalen, J. (Argonne National Lab., Ill. (USA)). Jun 1977. Contract W-31-109-ENG-38. 28p. Dep. NTIS, PC A03/MF A01.

Broad-resolution total neutron cross sections of carbon, iron and titanium are measured with varying sample thicknesses from approximately 1 to 4 MeV. Energy-averaged cross sections are deduced to accuracies of approximately less than 1%. The carbon values are consistent with previously reported precision measurements. The measured energy-averaged iron and titanium values are larger than the calculated energy average of some previously reported higher resolution measured and evaluated cross sections by as much as 10%. These differences may be indicative of a physical phenomenon which has implications on the design of fast-reactor systems.

57592 Cross section for the production of ^{7}Be from ^{6}Li, ^{6}Li interactions. Ruby, L.; Pyle, R.V.; Wong, Y.C. (Univ. of California, Berkeley). *Nucl. Sci. Eng.;* **63**: No. 2, 197-198(Jun 1977).

The cross section for the reaction ^{6}Li + ^{6}Li ^{7}Be + ^{4}He + n + 1.91 MeV has been measured at effective energies of 5.0, 3.5, and 1.6 MeV. The resulting large cross sections are 178 +- 6.4, 93.4 +- 6.0, and 3.89 +- 0.39 mb, respectively. Irradiations of ^{6}LiF targets were performed with a 6.0-MeV ^{6}Li-ion beam at the 88-in. cyclotron of the Lawrence Berkeley Laboratory.

57593 Inelastic interaction of high energy particles with light nuclei and the cluster structure of nuclei. Avdeichikov, V.V.; Bogatin, V.I.; Lozhkin, O.V. *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 1-7(Jan 1977).

The ΔE—E detector method has been used to study experimentally the formation of complex particles (the isotopes ^{2}H, ^{3}H, ^{3}He, and ^{4}He) in interaction of 660-MeV protons with the nuclei ^{9}Be, ^{10}B, ^{11}B, ^{12}C, and ^{27}Al. For the hydrogen and helium isotopes, the absolute production cross sections and the functions $d^{2}\sigma/dEd\Omega$ and $d\sigma/d\Omega$ have been measured over wide ranges of particle energies and angles in the laboratory system. The main kinematic characteristics of the secondary particles are analyzed, and a discussion is given of the mechanism of their production in terms of ideas regarding the cluster structure of nuclei.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57591

57594 Hydrogen and helium production cross sections for 15-MeV neutrons on types 316 and 304 stainless steel. Haight, R.C.; Grimes, S.M.; Anderson, J.D. (Univ. of California, Livermore). *Nucl. Sci. Eng.;* **63**: No. 2, 200-204(Jun 1977).

Hydrogen and helium production cross sections have been measured for 15-MeV neutrons incident on Types 316 and 304 stainless steel. A charged-particle magnetic-quadrupole spectrometer was used to measure the (n,xp), (n,xd), and (n,xα) cross sections and the charged-particle spectra. The measured gas production cross sections, 260 +- 38 mb for hydrogen and 48 +- 7 mb for helium, differ by as much as 73 percent from those used in previous assessments of candidate materials for fusion reactors. The energy spectrum of recoil nuclei from (n,xα) reactions, deduced here directly from the alpha-particle spectra, also differs from calculated spectra used in predicting displacement damage.

57595 Reactions ^{47}Ti(d,p)^{48}Ti and ^{49}Ti(d,p)^{50}Ti at a deuteron energy 13.6 MeV. Tokarevskii, V.V.; Shcherbin, V.N. (Nuclear Research Institute, Academy of Sciences, Ukrainian SSR). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 8-10(Jan 1977).

Differential cross sections have been measured for the (d,p) reaction in ^{47,49}Ti at a deuteron energy 13.6 MeV in the range of angles 6—171°. The experimental results are analyzed according to the DWBA, and the transition to the ground state of ^{48}Ti is also analyzed according to Hauser-Feshbach theory. Values of the spectroscopic factors are obtained for the states investigated.

57596 Inelastic interaction of muons with Fe nuclei at small Q^2 in the energy region above 200 GeV. Borog, V.V.; Kirillov-Ugryumov, V.G.; Petrukhin, A.A. (Moscow Engineering-Physics Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 46-51(Jan 1977).

It is shown that inelastic interaction of muons in cosmic rays corresponds in practice to a photoproduction process (Q^2 0.1 GeV^2). The results of an experiment performed with an ionization calorimeter point to constancy of the photonuclear cross section on iron nuclei, σ/sub γ/ = 4.1 +- 0.3 mb, up to energies 10^{12} eV. Comparison with accelerator data on the photonuclear cross section (σ/sub γN/ = 100 μb) yields for the shadow effect a value A/sub eff//A= 0.73 +- 0.06, which agrees with the γ-ray data at ~ 10 GeV.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

57597 (CONF-770115—1) **Fusion in Kr-bombardments of medium-mass nuclei.** Plasil, F. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 12p. Dep. NTIS, PC A02/MF A01.

From 15. international winter meeting on nuclear physics; Bormio, Italy (17 Jan 1977).

A brief look at concepts pertaining to interpretation of evaporation residue data is followed by a discussion of ongoing research on ^{86}Kr induced fusion reactions on intermediate mass nuclei. Results for ^{86}Kr + ^{63}Cu are compared with theory. (SDF)

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

57598 Emission of protons in π^{+} + Xe interactions at 2.34 GeV/c and Fermi motion of neutrons inside the nucleus. Slowinski, B.; Sredniawa, V.; Strugalski, Z. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 70-73(Jan 1977).

The results of investigating the angular and energy distributions of protons emitted in π^{+} + Xe interactions at 2.34 GeV/c are presented. The upper limit on the dispersion of the momentum distribution density function of the intranuclear neutrons of the Xe nucleus is estimated to be p_0 350 MeV/c. The proton emission mechanism is discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

57599 Angular-momentum transfer in deeply inelastic scattering of 610-MeV ^{86}Kr by ^{209}Bi. Dyer, P.; Puigh, R.J.; Vandenbosch, R.; Thomas, T.D.; Zisman, M.S. (University of Washington, Seattle, Washington 98195). *Phys. Rev. Lett.;* **39**: No. 7, 392-395(15 Aug 1977).

For the reaction 610-MeV ^{86}Kr + ^{209}Bi, angular correlations of fragments from fissioning heavy reaction products have been measured with respect to the recoil direction, both in and out of the reaction plane. The deduced angular momentum of the recoil particle is large, (50—70) h-bar, and is consistent with that of the sticking limit and greater than that of the rolling limit. This result demonstrates in importance of the tangential component of the frictional force.

SPONTANEOUS AND INDUCED FISSION

57600 Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction. Ignatyuk, A.V.; Itkis, M.G.; Okolovich, V.N.; Rus'kina, G.R.; Smirenkin, G.N.; Tishin, A.S. (Physics and Power Engineering Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 13-18(Jan 1977).

The isochronous cyclotron at the Nuclear Physics Institute of the Kazakh Academy of Sciences has been used to measure the angular distributions of fragments in the (α,f) reaction for the group of nuclei from Hf to Bi in th α-particle energy range 30—50 MeV. The data obtained have been used to determine and analyze the dependence of the effective moments of inertia on excitation energy and nucleonic composition of the fissioning nucleus.

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 55868

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 55868

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

57601 Search for superheavy elements in the bombardment of ^{248}Cm with ^{48}Ca. Hulet, E.K.; Lougheed, R.W.; Wild, J.F.; Landrum, J.H.; Stevenson, P.C.; Ghiorso, A.; Nitschke, J.M.; Otto, R.J.; Morrissey, D.J.; Baisden, P.A.; Gavin, B.F.; Lee, D.; Silva, R.J.; Fowler, M.M.; Seaborg, G.T. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev. Lett.;* **39**: No. 7, 385-389(15 Aug 1977).

We have searched for superheavy elements 110 to 116 with half-lives between 10^{4} and 10^{8} s in fractions chemically separated after each of a series of bombardments of ^{248}Cm made with 267-MeV ^{48}Ca ions. After 6 months of α and spontaneous-fission counting, our results provide no persuasive evidence for the presence of super-heavy elements. The most plausible explanation for not finding the superheavy elements is that they have either short half-lives or very small formation cross sections.

57602 Differential cross section of ^{238}U at 144 keV. Tsang, F.Y.; Brugger, R.M. (Univ. of Missouri, Columbia). *Trans. Am. Nucl. Soc.;* **26**: 163(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57603 Neutron capture cross section of ^{240}Pu. Weston, L.W.; Todd, J.H. (Oak Ridge National Lab., TN). *Nucl. Sci. Eng.;* **63**: No. 2, 143-148(Jun 1977).

The average ^{240}Pu capture cross section was measured from 200 eV to 350 keV. The cross section was normalized at thermal-neutron energies (0.02 to 0.03 eV), and this normalization was confirmed at the 1.06-eV resonance by the black resonance technique. The source of pulsed neutrons was the Oak Ridge Electron Linear Accelerator. The capture gamma-ray detector used was the "total energy detector," which is a modification of the Moxon-Rae detector. The shape of the neutron flux was measured relative to the ^{10}B(n,α) cross section up to 2 keV and the ^{6}Li(n,α) cross section at higher neutron energies. The results of the measurement define the average capture cross section of ^{240}Pu over a wide neutron energy range to an accuracy of approximately 8 percent, which is significantly better than previously known. The results indicate that the ENDF/B-IV evaluation is approximately 25 percent low above 30-keV neutron energy. The cross section is important in fast plutonium-fueled reactors.

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 57622

57604 Large collision residues and nuclear fission in the interaction of 25.2-GeV ^{12}C with uranium. Loveland, W.; Otto, R.J.; Morrissey, D.J.; Seaborg, G.T. (Lawrence Berkeley Laboratory and Department of Chemistry, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **39**: No. 6, 320-322(8 Aug 1977).

Target-residue mass and charge distributions have been measured for 76 products of the interaction of 25.2-GeV ^{12}C with U. The mass yield curve shows two prominent bumps: one for 80 < or = A < or = 145, resulting from the modest excitation-energy (50—100 MeV) fission of a species with A ~ 225, and the second for 160 < or = A < or = 190, apparently due to the survivors of a more central collision between projectile and target.

57605 Measurement of the fission cross section of ^{241}Pu from 8 eV to 70 keV. Carlson, G.W.; Behrens, J.W.; Czirr, J.B. (Univ. of California, Livermore). *Nucl. Sci. Eng.;* **63**: No. 2, 149-152(Jun 1977).

The ratio of the ^{241}Pu fission cross section to the ^{6}Li(n,α) cross section has been measured at neutron energies from thermal to 70 keV. The Lawrence Livermore Laboratory electron Linac provided a pulsed source of neutrons, and energies were measured by time-of-flight. The evaluated ^{6}Li cross section was used to obtain sigma(n,f) for ^{241}Pu from 8 eV to 70 keV and to normalize the results to the accepted thermal fission cross-section value.

57606 Measurement of the ^{238}U subthreshold fission cross section for incident neutron energies between 0.6 and 100 keV. Difilippo, F.C.; Perez, R.B.; de Saussure, G.; Olsen, D.K.; Ingle, R.W. (Oak Ridge National Lab., TN). *Nucl. Sci. Eng.;* **63**: No. 2, 153-166(Jun 1977).

The neutron-induced ^{238}U subthreshold fission cross section has been measured in the neutron energy range between 0.6 and 100 keV. A total of 28 fission clusters were identified. The well-known clusters at 721 and 1210 eV appeared resolved into their Class I components. Average ^{238}U subthreshold fission cross sections were determined and compared with available results in the literature. The measurement is interpreted in terms of fission doorway (Class II levels) arising from the assumption of the existence of a double-humped fission barrier for the (^{238}U + n) compound nucleus at large deformations. On the basis of this model, several fission barrier parameters were determined.

57607 Fission cross section of ^{249}Bk between 0.7 and 3.0 MeV. Silbert, M.G. (Los Alamos Scientific Lab., NM). *Nucl. Sci. Eng.;* **63**: No. 2, 198-200(Jun 1977).

The neutron-induced fission cross section of ^{249}Bk was measured over the threshold region near 1 MeV by time-of-flight techniques in conjunction with the underground nuclear explosion, Physics-8. The cross section rises from 0.1 b at 0.7-MeV neutron energy to a plateau of approximately 1.5 b from 1.6 to 3.0 MeV. Although our data extended down to 15-eV neutron energy, possible subthreshold fission in ^{249}Bk was obscured by the presence in the sample of a small amount of its fissile daughter, ^{249}Cf.

57608 Cross section for fission of ^{244}Pu by fast neutrons. Gokhberg, B.M.; Dubrovina, S.M.; Shigin, V.A. (I. V. Kurchatov Atomic Energy Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 11-12(Jan 1977).

Cross sections for fission of ^{244}Pu by neutrons have been measured in an electrostatic generator. The dependence of the cross section on energy has a threshold nature. The fission threshold is E/ sub n/=0.75 MeV, and the barrier height is accordingly 5.5 MeV. The cross section on the plateau is 1.1 b, which is substantially greater than that expected from the systematics based on Z and A of the fissioning nuclei. No appreciable irregularities are noted in the behavior of the cross section near threshold. The absence of irregularities places in doubt the presence in ^{245}Pu of a second barrier comparable in height with the first.

57609 X rays from fragments in fission of ^{235}U by 3.5-MeV neutrons. Donichkin, A.G.; Smirnov, A.N.; Eismont, V.P. (V. G. Khlopin Radium Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 19-23(Jan 1977).

We describe measurements of the yields and energy distributions of the K series of characteristic x rays of the fragments from fission of ^{235}U by neutrons of energy 3.5 MeV. The results are compared with the well-known results for thermal-neutron fission. The similarities and differences in the properties of the characteristic radiation are noted, and their significance for understanding the features of x-ray emission and the properties of the nuclear charge distribution is discussed.

57610 Manifestations of the viscosity of a fissioning nucleus in the kinetic energy of the fragments. Kuz'minov, B.D.; Sergachev, A.I. (Physics and Power Engineering Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 23-24(Jan 1977).

Measurements of the kinetic energy of the fragments in spontaneous and induced fission of nuclei are analyzed. We note a number of circumstances, characteristic of the aggregate of experimental data, which hamper the treatment of the partial contribution from the collective energy of a fissioning nucleus to the kinetic energy of the fragments.

57611 Method of obtaining photonuclear cross sections in the near-threshold region. Zhuchko, V.E. (Institute of Physics Problems, USSR Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 124(Jan 1977).

It is proposed that an efficient method of obtaining cross sections in photonuclear reactions is by means of the iteration method of minimization of the directed discrepancy. The method is applied to photofission of ^{235}U using a bremsstrahlung beam of energy 3.8-5.2 MeV.(AIP)

NUCLEAR THEORY

NUCLEAR STRUCTURE

57612 Isospin shift of the energy of the giant resonance. Berman, B.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.); Gibson, B.F. (Los Alamos Scientific Lab., N.Mex. (USA)); O'Connell, J.S. (National Bureau of Standards, Washington, D.C. (USA). Center for Radiation Research). *Phys. Lett., B;* **66**: No. 5, 405-409(28 Feb 1977).

Systematics of the peak position of the photonuclear giant dipole resonance are examined to extract the dependence upon the isospin of the target nucleus. The energy shift with isospin T at constant nuclear mass A is of the same sign and magnitude as the shift with A at constant T, in conflict with theoretical estimates.

57613 Self-consistent calculation of the neutron and proton densities of nuclei. Gonchar, V.Y.; Inopin, E.V.; Kuprikov, V.I. (Khar'kov Physico-technical Institute, Ukrainian Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 25-26(Jan 1977).

The Hartree-Fock method with a nucleon-nucleon interaction of the Skyrme-force type is used to calculate the differences between the neutron and proton densities of nuclei as well as the distribution of the neutron excess for nuclei with N<Z. The results are compared with the findings on the excess of the neutron radius over the proton radius obtained in other calculations and in experiments on the scattering of strongly interacting particles and electrons.

57614 Calculation of nuclear form factors by the method of hyperspherical functions. Sadovoi, A.A. *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 27-31(Jan 1977).

A method of calculating nuclear form factors using the method of hyperspherical functions (MHSF) is developed. The method can be applied in the minimal MHSF approximation and also when higher harmonics are taken into account. The calculations are performed with translationally invariant MHSF wave functions. The contributions of individual shells to nuclear form factors are investigated. Some special cases are considered as illustrations.

57615 Limits of nuclear stability. Gonchar, V.Y.; Derkach, L.M.; Inopin, E.V.; Kirichenko, Y.V. (Kar'kov Physico-technical Institute, Ukrainian Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 32-33(Jan 1977).

The Hartree-Fock method with an effective density-dependent Skyrme interaction is used to calculate the properties of nuclei far from the stability line and to determine the limits of nuclear stability. The results obtained are compared with semiempirical relations for nuclear masses and with experimental data. The Skyrme interaction leads to instability of nuclei consisting of only neutrons.

57616 Hartree-Fock method with an effective interaction that depends on the density and on the self-consistency condition. Inopin, E.V.; Barts, B.I.; Bolotin, Y.L. (Physico-technical Institute, Ukrainian Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 123-124(Jan 1977).

It is demonstrated that the self-consistency conditions are satisfied in a Hartree-Fock method that allows for the density dependence of the effective interaction. Several secondary effective interactions are introduced.(AIP)

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57597

57617 Analysis of excitation functions in (HI,xn) reactions on the basis of a simple evaporation model. Neubert, W. (Central Institute for Nuclear Research, GDR Academy of Sciences, Rossendorf). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 1, 33-38(Jan 1977).

350 measured excitation functions for (HI,xn) reactions are analyzed on the basis of a Fermi-gas model with allowance for the angular momentum of the compound nucleus. The role of the level-density parameter and of the critical angular momentum is discussed. Values of the nuclear temperature and of the level-density parameter are given as a function of the mass number at high excitation energies. Information is obtained about the yrast states in the final nuclei.

RADIOACTIVE DECAY

57618 Accurate approximations to average beta-particle energies and spectra. Stamatelatos, M.G.; England, T.R. (Los Alamos Scientific Lab., NM). *Nucl. Sci. Eng.;* **63**: No. 2, 204-208(Jun 1977).

A simple yet accurate approximation for calculating spectrum-averaged beta-particle energies and spectra is presented. It gives the average beta-particle energy as a ratio of two polynomials and can be easily implemented on pocket calculators. The values calculated by this method differ from those calculated by "exact" methods by less than 1 percent for nuclides with atomic numbers in the 20 to 100 range emitting beta particles having energies up to approximately 8 MeV (approximately 1.3 pJ).

57619 Decaying states. Peierls, R. pp 40-50 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

A review of decaying states is presented beginning with such states in Gamow's work on alpha decay, and including the expression of their eigenfunctions by the Green function of the Schroedinger equation, resonance scattering, and resonance eigenstates. 8 references. (JFP)

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

57620 (UCRL-Trans—11236) **Compton-radiation gas dynamics.** Imshennik, V.S. (AN SSSR, Moscow. Inst. Prikladnoj Matematiki). Apr 1977. Translation of Preprint No. 86, 1976, Institute of Applied Mathematics, Moscow. 40p. Dep. NTIS, PC A03/MF A01.

In high-temperature gas-dynamic processes a situation may occur wherein scattering, and not absorption, of photons may play the principal role in the interaction of radiation with matter. For instance, the medium may be optically thin relative to absorption. Then, bearing in mind the specifically Compton scattering of photons from electrons and confining ourselves to the nonrelativistic case (T much less than 5.93 x 10^9 K) we can formulate a system of Compton radiation gas dynamics (CRGD) equations, a particular case of which is the well-known radiant thermal conductivity approximation. The system of equations is derived on the basis of physically reasonable assumptions from the Boltzmann equation for photons and from general conservation laws. The Bose-Einstein distribution, in which the photon density is less than the equilibrium Planck distribution, is obtained as the main photon distribution function. Diffusion additions and effects due to motion of the medium are considered.

57621 Atomic collisions and fission technology. Datz, S. (Oak Ridge National Lab., TN). pp 833-845 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

Atomic physics aspects of fission technology are discussed, in particular, isotope enrichment and the slowing down of fission products, neutrons, etc., which leads to radiation damage and heating (and ultimately to power generation). Selective laser excitation of atoms or molecules promises to be a more efficient means of isotope separation than previous methods. Neutron radiation effects can be simulated in much less time by charged-particle transport. Problems in electronic and nuclear stopping of ions are reviewed. Energy loss spectra and stopping power for I ions are shown. 7 figs. (RWR)

SHIELDING CALCULATIONS AND EXPERIMENTS

REFER ALSO TO CITATION(S) 56651

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 57594

57622 (ORNL/TM—5938) **Data covariance files for ENDF/B-V.** Perey, F.G. (Oak Ridge National Lab., Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 41p. (ENDF—249). Dep. NTIS, PC A03/MF A01.

The formats and procedures for the data covariances of ENDF/B-V are presented. 5 tables.

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 57089, 57106

57623 (UCRL—79259) **Theoretical studies of soliton-like behavior of shocks in one-dimensional systems.** Hardy, J.R.; Karo, A.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Jul 1977. Contract W-7405-ENG-48. 16p. (CONF-770913—1). Dep. NTIS, PC A02/MF A01.

From International conference on lattice dynamics; Paris, France (5 Sep 1977).

Results are presented of numerical studies on shock propagation in one-dimensional lattices. Shocks were launched into these systems by both pulse and impact loading. The studies show that pulse-generated shocks are highly stable, and can spall atoms off the free ends of such lattices. They also can collide, pass through one another, and emerge unchanged. Impact loading generates multiple shocks and leads to multiple spall. The nature of this spall depends on the assumed interatomic potential. If this potential is such that the lattice is metastable, then the initial spall leads to extensive further spall which finally disrupts the lattice. 6 figures.

57624 Dielectric screening in one-dimensional disordered systems. Bush, R.L. (Univ. of Chicago). *Solid State Commun.;* **18**: No. 9-10, 1189-1192(1976).

The results of a calculation of dielectric screening in the random-phase approximation for a one-dimensional disordered system with no electron-phonon interactions are reported. At zero frequency, and small wavevector q the Thomas-Fermi form of the dielectric function becomes $\epsilon = 1 + \kappa^3/[q^2 + (\pi/2)(Lb)^{-2}]$, where κ is the inverse Thomas-Fermi screening length, and Lb is the exponential decay length of the Fermi-level wavefunctions in the random system. The presence of the randomness suppresses the Peierls distortion unless the electron-phonon coupling is very strong.

SUPERCONDUCTIVITY

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 57091, 57105, 57107, 57125, 57141

57625 Manifestations of 2 1/2-order transitions and Kohn singularities in the pressure dependence of the superconducting transition temperature. Makarov, V.I. (Khar'kov Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **3**: No. 1, 8-14(Jan 1977).

A theory is suggested for the pressure behavior of T/sub c/ in superconductors which accounts for changes due to pressure not only in the energy spectrum of conduction electrons but also in the phonon spectrum and in the electron—phonon interaction function. It is shown that in a superconductor subjected to pressure par. deltaT/sub c//par. deltaP may have two types of singularities: one type due to the 2 1/2-order transition and another due to Kohn singularity. The dependence of par. deltaT/sub c//par. deltaP on the impurity concentration is a reliable indicator which can be used to distinguish between these two types of singularities experimentally.

STATISTICAL PHYSICS AND THERMODYNAMICS

REFER ALSO TO CITATION(S) 57181

FUSION ENERGY

57626 Technology index for plasmaphysics research and fusion reactors. Volume 11, No. 6, 1977. Bibliography, author index, subject index, appendix. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1977). 53p.

This listing contains 236 references on various aspects of controlled fusion research. Subject and author indexes are included. (MOW)

57627 Technology index for plasmaphysics research and fusion reactors. Volume 11, No. 5, 1977. Bibliography, author index, subject index, appendix. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1977). 61p.

This listing contains 264 references on various aspects of plasma physics and thermonuclear reactor research. Subject and author indexes are included. (MOW)

PLASMA RESEARCH

REFER ALSO TO CITATION(S) 56390, 57089

PLASMA CONFINEMENT AND HEATING

57628 (ORNL/CSD/TM—27) **EBT time-dependent point model code: description and user's guide.** Roberts, J.F.; Uckan, N.A. (Oak Ridge National Lab., Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 94p. Dep. NTIS, PC A06/MF A01.

A D-T time-dependent point model has been developed to assess the energy balance in an EBT reactor plasma. Flexibility is retained in the model to permit more recent data to be incorporated as they become available from the theoretical and experimental studies. This report includes the physics models involved, the program logic, and a description of the variables and routines used. All the files necessary for execution are listed, and the code, including a post-execution plotting routine, is discussed.

57629 Radial boundary layers in diffusing toroidal equilibria. Rosen, M.D.; Greene, J.M. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **20**: No. 9, 1466-1475(Sep 1977).

Analytic results in straight cylindrical geometry imply sharp density gradients near the boundary of a plasma decaying by classical diffusion. Utilizing an isothermal one-fluid magnetohydrodynamic model, these results are applied to toroidal configurations and a set of nonlinear equations for a radial boundary layer are obtained. A dominant effect in this region is convective plasma flow along magnetic lines of force, with velocity in the sonic range. This flow pattern matches onto the interior solution of Pfirsch—Schlueter convective flow. Solutions separable in the radial and poloidal directions are found that fulfill both boundary and periodicity conditions, and that result in both smooth subsonic poloidal flow, and weak shock transonic flows. Effects of the flow patterns on diffusion are discussed.

57630 End loss from a collision dominated theta pinch plasma. McKenna, K.F.; York, T.M. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Fluids;* **20**: No. 9, 1556-1565(Sep 1977).

The plasma parameters and end loss in a collision-dominated theta pinch plasma have been investigated photographically, interferometrically, with axially arrayed diamagnetic probes and with a local pressure sensitive diagnostic. The compressed plasma (n/sub e/max$\sim 10^{17}$ cm^{-3}, T/sub e/=T/sub i/$\sim$45 eV) is highly stable for a period of approximately 9 μsec; the end-loss process is examined over this time interval. The development of a plasma throat region has been identified at an axial position of approximately one coil diameter within the theta pinch coil ends. The existence of inward propagating rarefaction waves is indicated from the plasma temperature time history. The plasma end-loss rate derived from local pressure measurements indicates an initial period of rapid particle loss followed by a period of gradual decay in the loss rate. The experimentally observed end-loss time is in excellent agreement with the prediction of a recent numerical magnetohydrodynamic computation.

57631 Evolution and thermonuclear yield of a high β plasma column. McMullin, J.N.; Capjack, C.E. (Department of Electrical Engineering, University of Alberta, Edmonton, Alberta, Canada T6G2E1). *Phys. Fluids;* **20**: No. 9, 1566-1570(Sep 1977).

The evolution of a high β linear θ pinch plasma is investigated by assuming a square density profile. A new analytic solution for the self-similar area wave is found for the case $\beta=1$, $\gamma=2$ and an exact integral of the motion of the reflected area wave is derived in the general case. The evolution of the plasma variables in the region between the reflected area waves is calculated numerically. Except for cases in which $(1-\beta)^{1/2}$ is approximately equal to a/b (plasma radius/solenoid radius), the density in this region is a slowing varying function of position. The relative fusion power production and total energy field is estimated, assuming constant temperature, for combinations of β and b/a relevant to two conceptual designs. It is found that in most cases significant power is produced after the area waves have reflected from the midplane of the solenoid. The model predicts that programming the applied magnetic field to simulate infinite b/a enhances the yield by approximately 85% for a 3-m neutron source but only by approximately 18% a 1-km fusion reactor.

57632 Energy loss rates of energetic ions injected into the FM-1 spherator. Davis, S.L.; Arunasalam, V.; Hawryluk, R.J.; Okabayashi, M.; Schmidt, G.L.; Schmidt, J.A.; Suckewer, S. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **20**: No. 9, 1571-1573(Sep 1977).

Energy loss rates of energetic ions were studied during neutral beam injection experiments on the FM-1 spherator. Under typical experimental conditions, the injected beam ions slowed-down on the plasma electrons resulting in electron heating. The measured slowing-down rate was found to be in agreement with classical predictions.

57633 Parametric investigation of mirror reactor dynamics. Galbraith, D.L.; Kammash, T. (Univ. of Michigan, Ann Arbor). *Trans. Am. Nucl. Soc.;* **26**: 83-84(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57634 Determination of plasma parameters in a fusion system. Bian, S. (Babcock and Wilcox Co., Lynchburg, VA). *Trans. Am. Nucl. Soc.;* **26**: 84-85(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 57336

57635 (CONF-770434—5) **ORNL plasma diagnostic research.** Hutchinson, D.P. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 4p. MF A01.

From SPIE x-ray imaging symposium; Reston, Virginia, United States of America (USA) (20 Apr 1977).

A high power optically-pumped submillimeter oscillator for use in plasma diagnostics has been developed which employs an unstable resonator cavity. This oscillator has been operated using CH_3I(447 μm), CH_3F (496 μm) and D_2O (385/361 μm). The peak power output varied from approximately 40 kW with CH_3I to 200 kW with D_2O.

57636 (CONF-770434—6) **Observation of tokamak plasmas with an array of pin diode detectors.** Jahns, G.L. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 5p. Dep. NTIS, PC A04/MF A01.

From SPIE x-ray imaging symposium; Reston, Virginia, United States of America (USA) (20 Apr 1977).

Soft x-ray emission from the Oak Ridge Tokamak (ORMAK) has been studied with an array of diode detectors. The thermal character of the plasma emission allows observation of phenomena associated with fluctuations in electron temperature. Measurements of internal disruption growth rates and repetition times corroborate a theoretical tearing-mode instability model. Heat pulses from the disruption evolve diffusively, but with a heat conduction coefficient larger than that inferred from the plasma equilibrium.

57637 Local diagnostics of impurity ions in a hot plasma. Afrosimov, V.V.; Gordeev, Y.S.; Zinov'ev, A.N. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Tech. Phys. Lett. (Engl. Transl.);* 3: No. 2, 39-40(Feb 1977).

It is shown that it is possible to determine oxygen and carbon impurities of 0.1-1.0% in tokamaks by injection of a beam of fast hydrogen atoms. (AIP).

57638 Stark effect in three-dimensional stochastic electric fields and a static magnetic field of a helium plasma. Kim, S.H. (Department of Nuclear Engineering, Hanyang University, Seoul 133, Korea). *J. Appl. Phys.;* **48**: No. 9, 3651-3659(Sep 1977).

Atomic absorption spectra of the He I plasma in the static magnetic field in the absence of laser radiation are different from

spectra in the presence of laser radiation. Especially, it has been theoretically predicted that the spectral shift of the satellite line, which is seen in the latter case, does not exist in the former case. In this paper, the effect of three-dimensional high-frequency electric fields on the σ/sub +/, σ/sub -/, and π components of the allowed $1\ ^1S_0$-$3\ ^1P_1$ transition and the forbidden $1\ ^1S_0$-$3\ ^1D_2$ lines in atomic absorption spectra of the He I plasma in a static magnetic field in the absence of a laser beam is investigated from the coupled equations for the probability amplitudes of atomic states. It is shown that they should give rise to a spectral shift of the allowed lines and satellites about forbidden lines. The calculation reveals that the shift is proportional to the mean-square stochastic electric field, and that the ratio of the intensity of the near satellite to that of the far satellite is different from the ratio obtained by the second-order perturbation theory or the three-level rotating-wave approximation. Discussion is given for the validity of this theory.

57639 Axial density and temperature variations in a magnetically confined arc. Marhic, M.E.; Kwan, L.I. (Department of Electrical Engineering, Northwestern University, Evanston, Illinois 60201). *J. Appl. Phys.;* **48**: No. 9, 3713-3717(Sep 1977).

Axial variations of electron density n/sub e/ and temperature T/sub e/ have been found in magnetically confined arcs assumed by other workers to be axially uniform. Results of measurements using plasma radiation, swiveling water-cooled electrostatic probes, and Thomson scattering of dye laser radiation are presented. The axial variations depend only weakly upon magnetic field strength, arc current, distance between the electrodes, and cathode diameter, but depend strongly upon gas pressure p. T/sub e/ does not always vary monotonically with distance, but n/sub e/ usually decreases away from the cathode. For all measurements reported here, $4 \times 10^{14} < n/\text{sub e}/ < 2.2 \times 10^{15}$ cm^{-3} and $0.6 < T/\text{sub e}/ < 2.6$ eV.

57640 Simultaneous determination of the temperature and density of metal atoms in a plasma. Zhiglinskii, A.G.; Kuchinskii, V.V.; Milovanov, N.P.; Presnukhina, I.P. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 4, 448-449(Apr 1977).

A plasma diagnostic method is proposed based on the brightness distribution in the hfs of spectral lines.(AIP).

57641 Raman scattering: a possibility of calibrating laser scattering devices. Roehr, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). *Phys. Lett.;* **60A**: No. 3, 185-186(21 Feb 1977).

In certain plasma devices it is impossible to calibrate a laser light scattering experiment by Rayleigh scattering. In such cases Raman scattering may be a suitable method. The cross-sction of the strongest Raman line of SF_6 has been measured and compared with the Thomson cross-section.

57642 10-channel neutral particle energy analyser for measurements of ion temperatures on tokamak plasmas. Takeuchi, H.; Funahashi, A.; Takahashi, K.; Shirakata, H.; Yano, S. (Jpn At Energy Res Inst, Tokai Establ, Ibaraki). *Jpn. J. Appl. Phys.;* **16**: No. 1, 139-147(Jan 1977).

A 10-ch neutral particle energy analyser and its application to JAERI-tokamak devices are described. The analyser is a 45-degree parallel-plate electrostatic type with ten ion detectors. The analyser was calibrated for the energy and transmission efficiency by using electron and proton beams, and the conversion efficiency in the charge-stripping cell was experimentally obtained with hydrogen-atom beams. By using the analyser, ion temperatures of the JFT-2a and JFT-2 devices has been measured. It is found that the ion temperature can be determined with sufficient accuracy from six plasma shots (three shots to measure particle signals and three shots to determine background noises). The peak ion temperatures ranging from 80 to 350 eV are about ($one-half$–$one quarter$) of the central electron temperatures. 23 refs.

57643 Subpicosecond proximity-focused streak camera for x-ray and visible light. Lieber, A.J.; Sutphin, H.D.; Webb, C.B. (Univ of Calif, Los Alamos Sci Lab, NM). *SPIE Semin. Proc.;* **94**: 7-12(1977).

Laser-fusion requires diagnostics of high-density, high-temperature plasmas on the pico-second time scale. To this end a proximity-focused streak camera has been under development. An x-ray version of this device has been constructed and tested using x-rays generated by irradiating microballoon targets with a two-beam Nd:glass laser. Results indicate the prototype to be of high sensitivity with temporal resolution of 2.5 to 3 ps. Later production cameras based upon this design are expected to give sub-picosecond temoral resolution for both x-ray and visible light. The camera is simple, compact, rugged and vacuum compatible. It has proved 98% reliable in over 350 laser shots. Applications to other disciplines are discussed. 13 refs.

57644 Ultrafast x-ray diagnostics for laser fusion experiments. Coleman, L.W. (Univ of Calif, Lawrence Livermore Lab.). *SPIE Semin. Proc.;* **94**: 19-29(1977).

Temporally, spectrally, and spatially resolved x-ray emission diagnostics are important tools in the study of the heating and compression of laser fusion targets by sub-nanosecond laser pulses. The use of the Livermore 15 psec resolution x-ray streak camera to make such measurements is reviewed. Temporal histories of spectrally resolved x-ray emission in the 1-10 keV range have been obtained. The x-ray streak camera has been used in conjunction with a specially designed pinhole imaging system to temporally record images of laser compressed targets with a spatial resolution of approximately 6 mum. Implosion characteristics are presented for experiments with glass microshell targets. The concept, development, and testing of an ultrafast framing camera for full two-dimensional time resolved imaging is discussed. A prototype camera, based on the image dissection-restoration concept, has achieved an approximately 200 psec frame period with a resolution of 50 mum. 36 refs.

PLASMA KINETICS - GENERAL

57645 Plasma rotations induced by 3.5-MeV alpha-particle losses. Petrie, T.W.; Miley, G.H. (Univ. of Illinois, Urbana). *Trans. Am. Nucl. Soc.;* **26**: 85-86(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57646 Atomic physics in the controlled thermonuclear research program. Barnett, C.F. (Oak Ridge National Lab., TN). pp 846-853 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The atomic processes involving plasma heating, cooling, and diagnostics are discussed. Also, of interest are those atomic processes involved in the interaction of a high temperature plasma with the vacuum wall. (MOW)

PLASMA KINETICS - EXPERIMENTAL

57647 Plasma impurity radiation from iron and silicon. Hopkins, G.R.; Rawls, J.M. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **26**: 79(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

PLASMA KINETICS - THEORETICAL

REFER ALSO TO CITATION(S) 57826

57648 Application of a unified slowing-down theory to fusion plasmas. Choi, C. (Univ. of Illinois, Urbana, IL); Bathke, C.; Miley, G. *Trans. Am. Nucl. Soc.;* **26**: 81-82(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57649 Time reduction techniques for neutral atom transport by multigroup methods. Gilligan, J.G. (Princeton-Plasma Physics Lab., NJ); Gralnick, S.L.; Price, W.G. Jr.; Kammash, T. *Trans. Am. Nucl. Soc.;* **26**: 87-88(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57650 Asymptotically exact theory of electron exchange in distant collisions. Demkov, Yu.N. pp 313-326 of In Physics of electronic and atomic collisions. Risley, J.S. (ed.). Seattle; University of Washington Press (1976).

From 9. international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

See CONF-750705—.

The main points are given of an asymptotically exact theory for the tunneling processes which give an exact asymptotic expansion of the important quantities approaching exact ones when the barrier becomes bigger and bigger. (MOW)

PLASMA PRODUCTION

57651 Charge separation and target voltages in laser-produced plasmas. Pearlman, J.S.; Dahlbacka, G.H. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Appl. Phys. Lett.;* **31**: No. 7, 414-417(1 Oct 1977).

Measurement of the voltages of isolated targets irradiated with 50-psec laser pulses show kilovolt target potentials existing for many nanoseconds. The amplitude of the voltage exceeds what is normally expected for a plasma pressure gradient by roughly an order of magnitude. The voltage amplitude and temporal characteristics are found to be dependent on the vacuum chamber dimensions.

A simple one-dimensional plasma model explains the voltage characteristics through the existence of space-charge separation effects and leads to a measurement of the plasma temperature.

57652 Neutron and energetic ion production in exploded polyethylene fibers. Young, F.C.; Stephanakis, S.J.; Mosher, D. (Naval Research Laboratory, Washington, D.C. 20375). *J. Appl. Phys.;* **48**: No. 9, 3642-3650(Sep 1977).

Neutron production in exploded-fiber z-pinch plasmas containing hydrogen or deuterium is reported. Yields in excess of 10^{10} neutrons have been measured with deuterated fibers. The character of the neutron emission changes from that consistent with a thermal-fusion source for large fiber diameters (100 μm) to one primarily due to energetic ion collisions for small fiber diameters (<25 μm). In the latter case, more than 10^{13} ions of multi-MeV energies have been observed. This transition in the character of neutron emission is correlated with a fundamental change in the nature of the plasma as evidenced by resistivity measurements.

57653 Operation of a plasma-focus device with D_2 and He^3. Gullickson, R.L.; Luce, J.S.; Sahlin, H.L. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Appl. Phys.;* **48**: No. 9, 3718-3722(Sep 1977).

Two plasma-focus devices at the Lawrence Livermore Laboratory, the B Division device (BDPF), with a stored energy of 73 kJ at 18 kV, and the Physics Department device (PDPF), with a stored energy of 67 kJ at 20 kV, were operated with various mixtures of D_2 and He^3. The purpose of the experiments was to evaluate the D-D/D-He^3 yield ratio as a diagnostic tool for determining the plasma ion temperature. Measurements were made in the high-pressure mode (total pressure of 4.0 Torr for the BDPF, 7.5 Torr for the PDPF), where previous measurements using carbon activation showed no significant ion acceleration to energies above the 330-keV carbon (d,n) reaction threshold. The yield from the D(d,n)He^3 reaction was determined from measurements of the total neutron yield using the standard silver-activation technique. The yield from the He^3(d,p)He^4 reaction was determined by measuring the reaction-product protons by copper activation. The Cu anode insert from the center electrode was analyzed for γ activity following each series of shots to measure the presence of Zn^{63} from the 4.21-MeV-threshold Cu^{63}(p,n)Zn^{63} reaction. The thick-target yield for this reaction at the proton energy of 14.6 MeV was calculated from cross-section data, giving a value of 7.5 x 10^{-4} Zn^{63} atoms per incident proton. In operation with 50/50 atomic or molecular mixtures of D_2 and He^3, the D-D/D-He^3 yield ratio varied from a minimum of 13.6 to a maximum of 60.5. This corresponds to a plasma temperature range from 4.0 to 6.5 keV, or if a beam-target model is assumed, to a deuteron beam ranging in energy from 28 to 47 keV incident upon stationary He^3 ions. Operating with fractions of He^3 ranging from 0.053 to 1.0 at a total pressure of 4 Torr, the D-D neutron yield showed the expected dependence on the square of the deuterium fraction [f (D)].

57654 High-current plasma accelerator for the investigation of plasma wall interaction. Martin, C.; Mueller, K.G.; Tuczek, H.; Bieger, W.; Gresser, H.; Richter, F. (Universitaet Essen: Gesamthochschule, 4300 Essen 1, Postfach 6843, West Germany). *J. Appl. Phys.;* **48**: No. 9, 3723-3726(Sep 1977).

An accelerator producing quasicontinuous homogeneous plasma beams by means of a traveling wave has been developed. By a special feedback system, beams with a density of the order 10^{12} cm^{-3} and ion energies of the order of 100 eV can be produced corresponding to an equivalent current of 240 A. The accelerator is applied to the simulation and investigation of special aspects of the plasma wall interaction.

57655 Method and apparatus for generating and utilizing a compound plasma configuration. Koloc, P.M. US Patent 4,023,065. 10 May 1977. Filed date 24 Oct 1973. 16p.

A method and apparatus for generating and utilizing a compound plasma configuration is disclosed. The plasma configuration includes a central toroidal plasma with electrical currents surrounded by a generally ellipsoidal mantle of ionized particles or electrically conducting matter. The preferred methods of forming this compound plasma configuration include the steps of forming a helical ionized path in a gaseous medium and simultaneously discharging a high potential through the ionized path to produce a helical or heliform current which collapses on itself to produce a toroidal current, or generating a toroidal plasmoid, supplying magnetic energy to the plasmoid, and applying fluid pressure external to the plasmoid. The apparatus of the present invention includes a pressure chamber wherein the compound plasma configuration can be isolated or compressed by fluid or other forms of mechanical or magnetic pressure. 47 claims, 10 figures.

57656 Interaction of TEA CO_2 laser light with laser produced plasma. Yamabe, C.; Setoyama, E.; Thein, A.; Yokoyama, M.; Yamanaka, C. (Nagoya Univ, Jpn). *Jpn. J. Appl. Phys.;* **16**: No. 1, 131-137(Jan 1977).

The experimental results of the anomalous absorption due to the parametric instability of the laser produced plasma by focusing the double discharge type TEA CO_2 laser light on the targets of carbon plate, polyethylene terephtalate film and polyethylene plate are described. The higher harmonics generation from the laser produced plasma is also observed. 14 refs.

57657 Absolute measurements of photon flux from a laser plasma in the vacuum ultraviolet. Afrosimov, V.V.; Belik, V.P.; Bobashev, S.V.; Shmaenok, L.A. (Physical-Technical Inst., Leningrad). *Pis'ma Zh. Tekh. Fiz.;* **1**: 851-854(26 Sep 1975). (In Russian).

A pulsed Nd laser is used to generate a plasma which emits a flux of photons into the ionization chamber of a time-of-flight mass spectrometer, filled with a rare gas which is ionized by the photons. The spectrometer is calibrated by a beam of monoenergetic electrons. The investigation has been conducted to study the possibilities of using this method for the photoionization of atoms, and the feasibility of extending it to the X-ray range.

57658 Experimental investigation of a discharge in a high-current coaxial plasma source. Babkin, G.V.; Mikhalev, V.G.; Ogorodnikov, S.N.; Orlov, R.V.; Potapov, A.V. *Zh. Tekh. Fiz.;* **45**: 1855-1861(Sep 1975). (In Russian).

The distribution of the parameters of an alkaline metal plasma in the working volume of a high-current coaxial plasma source is studied. It is shown that the discharge crisis characterized by transiton from a stable to unstable regime with significant changes in the electric parameters and a sharp voltage rise for fixed average mass consumption of the active substance occurs when the degree of ionization is close to unity. Experimental data are presented on the behavior of the plasma parameters associated with the transformation of the discharge.

57659 Formation of plasma focus in erosion-type plasma accelerators. II. Grishin, Yu.M. (Moscow Higher Technical School). *Zh. Tekh. Fiz.;* **45**: 1869-1877(Sep 1975). (In Russian).

The paper discusses the compression flow of a plasma beyond the exit of an erosion-type quasi-steady accelerator in which the plasma flow is assumed to be polytropic. Formation of plasma focus is analyzed in two steps: plasma collapse toward the axis of the system and compression of this structure under the influence of inertial and electromagnetic forces. Essential criteria are obtained for determining the degree of compression, concentration and temperature of the plasma at the focus.

PLASMA INSTABILITIES

57660 (COO—3077-137) **Elements of magnetohydrodynamic stability theory.** Spies, G.O. (New York Univ., N.Y. (USA). Courant Inst. of Mathematical Sciences). Nov 1976. Contract EY-76-C-02-3077. 76p. (MF—86). Dep. NTIS, PC A05/MF A01.

The nonlinear equations of ideal magnetohydrodynamics are discussed along with the following topics: (1) static equilibrium, (2) strict linear theory, (3) stability of a system with one degree of freedom, (4) spectrum and variational principles in magnetohydrodynamics, (5) elementary proof of the modified energy principle, (6) sufficient stability criteria, (7) local stability, and (8) normal modes. (MOW)

57661 (LA-UR—77-1142) **Feedback stabilization experiments using l = 2 equilibrium windings in Scyllac.** Bartsch, R.R.; Cantrell, E.L.; Gribble, R.F.; Freese, K.B.; Handy, L.E.; Kristal, R.; Miller, G.; Quinn, W.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 5p. (CONF-770906—1). Dep. NTIS, PC A02/MF A01.

From 8. European conference on controlled fusion and plasma physics; Prague, Czechoslovakia (19 Sep 1977).

The confinement time in the Scyllac Sector Feedback Experiment has been extended with a pre-programmed equilibrium compensation force. This force was produced by driving a current with a flexible waveform in an additional set of l = 2 windings.

57662 (ORNL/TM—5968) **Reduction of the growth rate of the m = 1 resistive magnetohydrodynamic mode by finite gyroradius effects.** Waddell, B.V.; Laval, G.; Rosebluth, M.N. (Oak Ridge National Lab., Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 39p. Dep. NTIS, PC A03/MF A01.

The reduction in the growth rate of the m = 1 resistive magnetohydrodynamic (MHD) mode due to finite gyroradius effects is determined. Specifically, equilibrium diamagnetic flows, the Hall (or diamagnetic) term in Ohm's law, and ion viscosity are taken into account. The analysis is carried out in cylindrical geometry; toroidal corrections are included in only a very restricted sense. The calculation is valid in the limit where Braginskii's two-fluid equations are valid, i.e., where collision frequencies are large compared to the mode frequency and mean free paths are shorter than the relevant scale lengths. It is shown that the decrease in the mode growth rate due to ion viscosity is small for present-day tokamak parameters. On the other hand, diamagnetic drifts can significantly reduce the

growth rate in both the ideal MHD and the resistive limits. In fact, in the ideal MHD limit, the mode can be completely stabilized if the pure MHD growth rate is less than half the ion diamagnetic drift frequency. Although the mode cannot be stabilized in the resistive limit, the growth rate is reduced by a factor of $\gamma^2/\text{sub T//parallel } \omega/\text{sub *i//}\omega/\text{sub *e/parallel}$, where γ /sub T/ is the purely resistive (tearing) growth rate and $\omega/\text{sub *i/}$ and $\omega/\text{sub *e/}$ are respectively the ion and electron diamagnetic drift frequencies.

57663 (PPPL—1349) Comparative numerical studies of ideal magnetohydrodynamic instabilities. Chance, M.S.; Greene, J.M.; Grimm, R.C.; Johnson, J.L.; Manickam, J.; Kerner, W.; Berger, D.; Bernard, L.C.; Gruber, R.; Troyon, F. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jun 1977. Contract EY-76-C-02-3073. 23p. Dep. NTIS, PC A02/MF A01.

Stability properties associated with a specific analytic equilibrium have been calculated to compare the accuracy of three large computational programs that have been developed at Garching, Princeton, and Lausanne. All three use a Galerkin formulation of the variational principle for determining spectra. Good agreement is found, verifying the efficacy of all three codes.

57664 (PPPL—1354) Microinstability theory in tokamaks: a review. Tang, W.M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jun 1977. Contract EY-76-C-02-3073. 175p. Dep. NTIS, PC A08/MF A01.

Significant investigations in the area of tokamak microinstability theory are reviewed. Emphasis is given to the work covering the period from 1970 through 1976. Special attention is focused on low-frequency electrostatic drift-type modes, which are generally believed to be the dominant tokamak microinstabilities under normal operating conditions. The basic linear formalism including electromagnetic (finite beta) modifications is presented along with a general survey of the numerous papers investigating specific linear and nonlinear effects on these modes. Estimates of the associated anomalous transport and confinement times are discussed, and a summary of relevant experimental results is given. Studies of the nonelectrostatic and high-frequency instabilities associated with the presence of high energy ions from neutral beam injection (or with the presence of alpha particles from fusion reactions) are also surveyed.

57665 Initial value problem with non-Hermitian radial mode equations. Horton, W. Jr.; Kwak, H.; Estes, R.; Choi, D. (Fusion Research Center and Department of Physics, The University of Texas at Austin, Austin, Texas 78712). *Phys. Fluids;* **20**: No. 9, 1476-1482(Sep 1977).

A biorthogonal set of expansion functions is introduced for the radial mode problem that occurs for drift waves and trapped particle modes in nonuniform plasmas. With a vector space representation of the eigenfunctions concise time dependent and time independent perturbation theory formulae are obtained for the system.

57666 Nonlinear propagation of ion-cyclotron modes. Spatschek, K.H.; Tagare, S.G. (Fachbereich Physik, Universitaet Essen, Federal Republic of Germany). *Phys. Fluids;* **20**: No. 9, 1505-1509(Sep 1977).

It is shown that the nonlinear interaction of large amplitude electrostatic ion-cyclotron oscillations with low-frequency perturbations causes a modulational instability. The most important cases of adiabatic density perturbations and low-frequency changes in the magnetic field strength are considered. The nonlinear equation which governs the asymptotic state of the modulationally unstable ion-cyclotron mode admits a soliton or soliton-like solution for the electric potential.

57667 Influence of strong inhomogeneities on high-frequency mirror-drift-cone and convective-loss-cone instabilities. Davidson, R.; Gladd, N.T. (Division of Magnetic Fusion Energy, Energy Research and Development Administration, Washington, D. C. 20545). *Phys. Fluids;* **20**: No. 9, 1516-1524(Sep 1977).

The basic linear local theory of the mirror-drift-cone and convective-loss-cone instabilities is extended to include modifications due to strong spatial inhomogeneities (vertical-barpartiallnN/partialxvertical-bar^{-1}=L/sub N/approximately-less-thanr/sub L i/), assuming high-frequency perturbations characterized by $\omega/\text{sub c i/}$ very-much-less-thanvertical-bar$\omega/\text{sub r/}+ i\gamma$vertical-bar ($\omega/\text{sub c e/}\omega/\text{sub c i/})^{1/2}$ and $k^2/\text{sub y/r}^2/\text{sub L i/}$very-much-greater-than1. The continuous deformation of the convective-loss-cone instability from a regime where maximum growth occurs for kxB_0not-equal0 (weak inhomogeneities) to a regime where maximum growth occurs for $kxB_0=0$ (strong inhomogeneities) is investigated. Moreover, it is found that the reference dispersion relation for the mirror-drift-cone instability (derived in the weak inhomogeneity limit with $r^2/\text{sub L i/}$ very-much-less-than$L^2/\text{sub n/}$) gives a remarkably good (albeit fortuitous) estimate of the linear growth rate even when r/sub L i/ approximately-greater-than$L/\text{sub n/}$. Finally, we compare several properties of the mirror-drift-cone and convective-loss-cone instabilities (loss-cone ions) with properties of the lower-hybrid-drift and modified-two-stream instabilities (Maxwellian ions).

57668 Unified formalism of lower hybrid parametric instabilities in plasmas. Tripathi, V.K.; Grebogi, C.; Liu, C.S. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **20**: No. 9, 1525-1534(Sep 1977).

A unified theory of parametric instabilities in the lower hybrid frequency region is formulated using the drift kinetic equation for electrons and the Vlasov equation for unmagnetized ions. The three wave decay process into various decay channels (viz., two lower hybrid waves, lower hybrid and ion acoustic waves) are examined and compared for various pump frequencies and powers. Nonlinear scattering rates by electrons and ions (i.e., nonlinear Landau damping) are evaluated and compared with previous calculations. It is seen that the dominant channel of decay is through ion acoustic and lower hybrid waves when $T/\text{sub e//2T/sub i/}<4$ and through lower hybrid waves and lower hybrid quasi-modes when $T/\text{sub e//2T/sub i/}<4$.

57669 Three-wave parametric-decay instability with arbitrary dissipation in homogeneous plasmas. Fuchs, V. (Direction Sciences de base, Institut de recherche de l'Hydro-Quebec, Varennes, Quebec, Canada JOL 2PO). *Phys. Fluids;* **20**: No. 9, 1535-1543(Sep 1977).

The theory of the nonlinear decay of a steady incident pump wave into two oppositely propagating modes in a bounded homogeneous region is extended to include arbitrary dissipation on each wave. A new representation of the coupled mode equations shows that, in addition to the usual coupling nonlinearity, two transverse-wave-damping-induced nonlinearities appear, leading to enhanced saturation. A threshold analysis yields general absolute and convective instability criteria extending earlier results of Kroll, and of Porkolab and Chang. The steady-state boundary value problem is solved to obtain the eigenvalue of the stimulated backscattering problem, the anomalous reflectivity, or the convective amplification of a noise source. Good agreement is found between the results of analytical and numerical integrations.

57670 Neutral beam driven convective loss cone instability in toroidal geometry. Hitchcock, D.A.; Brecht, S.H.; Horton, W. Jr. (Fusion Research Center, The University of Texas, Austin, Texas 78712). *Phys. Fluids;* **20**: No. 9, 1551-1555(Sep 1977).

When a neutral beam is injected into a tokamak obliquely to the magnetic field, a region where $\text{partialF/sub b//partialv}^2/\text{sub perpendicular/}<0$ may develop which can drive the convective loss cone instability. From a slab model with magnetic shear, low thresholds ($n/\text{sub b//n/sub e/}\sim 10^{-3}$) and substantial growth rates are found for parameters of interest for present and future tokamaks.

57671 Experimental and numerical studies of magnetohydrodynamic stability properties of a rectangular-cross-section finite-β toroidal plasma. Allen, A.W.; Cochran, F.L.; Goldenbaum, G.C.; Liewer, P.C. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Rev. Lett.;* **39**: No. 7, 404-407(15 Aug 1977).

The dependence of the growth rate of the $n = 1(\lambda = 2\pi R_0)$ kink instability on plasma β has been investigated experimentally in a rectangular-cross-section high-toroidal-β [$\beta/\text{sub t/}$ (axis) approximately-greater-than 10%] device and compared with theoretical predictions. The $\beta/\text{sub t/}$ for the onset of instability as well as the estimated values of the growth rates observed experimentally are in good agreement with predictions from a numerical ideal magnetohydrodynamic model.

57672 Development of two- and three-dimensional perturbations in the case of an ionization instability in a channel with nonconducting walls. Zubtsov, V.M.; Sinkevich, O.A. *Fluid Dyn. (USSR) (Engl. Transl.);* **11**: No. 3, 445-448(May-Jun 1976).

An ionization instability of a plasma bounded by nonconducting walls is investigated taking into account electron thermal conduction. The wave vector is considered directed at some angle to the magnetic field direction. Perturbations with a wave vector orthogonal to the magnetic field induction vector turn out to be most unstable. A relatively simple formula to compute the neutral curve separating the stability and instability domains is obtained.

57673 Thermonuclear cyclotron magnetosonic instability of plasma. Belikov, V.S.; Kolesnichenko, Ya.I. *Zh. Tekh. Fiz.;* **45**: 1798-1808(Sep 1975). (In Russian).

The study shows that the presence of a small amount of thermonuclear reaction products in a deuterium-tritium plasma is enough to excite cyclotron magnetosonic waves. Criteria for the occurrence of instability are obtained. A comparison is drawn between conditons for the development of instability in a toroidal system and in an adiabatic trap. The effectivenss of stabilizing the resulting instability by means of a shear is discussed.

PLASMA WAVE PHENOMENA

57674 (AD-A—037663) An experimental and theoretical study of the propagation of high amplitude pulses in a bounded magnetoplasma. Interim report. Kunhardt, E.E.; Cheo, B.R.S. (Polytechnic

Inst. of New York, Brooklyn (USA). Dept. of Electrical Engineering and Electrophysics). Jun 1976. 119p. (POLY-EE/EP—76-011). NTIS PC A06/MF A01.

Experiments on the propagation of narrow, high amplitude pulses along a plasma column have been conducted. The evolution of the pulse in space-time has been observed as a function of initial pulse strength. This technique gives insight into the competitive effects due to dispersion and nonlinearities. For a plasma, the positive column of a hot cathode, D.C. discharge in Argon is used. The pressure varied from 1 to 10m Torr Hg, and the averaged electron densities are of the order of 10 to the 9th power to 10 to the 10th power per. The pulses for excitation are generated by a home made device capable of producing subnanosecond pulses with 3200 volts peak amplitude, into a 50 OHM line, at a repetitive rate of approximately 100 p.p.s. At each operating point, i.e., for a given pressure and discharge current, recordings were obtained for different values of excitation pulse amplitude and background static magnetic field. For zero static magnetic field, two types of recordings were taken. For the first type, the position of the receiver was fixed and oscillograms in time were recorded. In the second type, the sampling time is kept fixed and the receiving probe is moved along the column.

57675 (UCRL—13727) **Trapped particles and harmonic generation.** Hobbs, W.E. Jr.; DeGroot, J.S. (California Univ., Davis (USA). Dept. of Applied Science). [nd]. Contract W-7405-ENG-48. 19p. Dep. NTIS, PC A02/MF A01.

A novel fluid-particle algorithm has been used to study the evolution of continuously generated ion acoustic waves numerically. The code permits the simultaneous analysis of the two nonlinearities involved: wave steepening or harmonic generation, a fluid effect; and wave damping and amplitude oscillations, a particle effect. For a temperature ratio $10 < T/T_i < 30$, the behavior of low amplitude long wavelength waves is well described by a Korteweg-deVries equation augmented to include a time dependent damping term.

57676 (UCRL—79604) **Wave-breaking amplitudes in warm, inhomogeneous plasmas.** Kruer, W.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Jun 1977. Contract W-7405-ENG-48. 12p. (CONF-770571—1). Dep. NTIS, PC A02/MF A01.

From Anomalous absorption conference; Vancouver, British Columbia, Canada (10 May 1977).

The effect of plasma temperature on reducing the wave-breaking amplitude of resonantly-driven fields is shown. Some applications to laser fusion are given.

57677 **Observation of nonlinear Landau damping of a broad-band spectrum of electron plasma waves.** Gervais, F.; Olivain, J.; Quemeneur, A.; Matthieussent, G. (Association Euratom-CEA sur la Fusion, Departement de Physique du Plasma et de la Fusion Controlee, Centre d'Etudes Nucleaires, 92260 Fontenay-aux-Roses, France). *Phys. Fluids;* **20**: No. 9, 1488-1498(Sep 1977).

Considering the interaction of a spectrum of electron plasma waves with a plasma, in the framework of weak turbulence analysis, a formulation of the nonlinear Landau mechanism is developed, which takes into account finite radial geometrical effects. The formulation of the spectrum evolution and of the deformation of the distribution is given. Experimental results concerning the spectrum and the distribution are compared with this analysis. In particular, the observation of the beat disturbance identifies the mechanism. Moreover, an experimental limit of validity of the weak turbulence analysis is given.

57678 **Propagation of nonlinear waves along a magneto-plasma column.** Kunhardt, E.E.; Cheo, B.R. (Department of Electrical Engineering, Texas Tech University, Lubbock, Texas 79409). *Phys. Fluids;* **20**: No. 9, 1499-1504(Sep 1977).

Nonlinear waves propagating along a magneto-plasma column are investigated on the basis of the cold fluid model. Three regimes are studied in detail: (1) column in free space, zero magnetic field (surface waves), (2) column surrounded by conductor, weak axial dc magnetic field, i.e., $\omega/\omega_{ce} < \omega/\omega_{pe}$, (3) column surrounded by conductor, large axial magnetic field. For each case, the evolution in space of the modal amplitude, which is shown to act as a potential from which the longitudinal component of the electric field may be obtained, is described by a Korteweg—de Vries equation. For a given initial condition, each case is shown to behave quantitatively differently due to differences in the magnitude and sign of the nonlinear and dispersive terms. Correlation with experimental results are discussed.

57679 **Nonlinear distortion of propagation cones of lower hybrid wave in an inhomogeneous plasma.** Sanuki, H.; Ogino, T. (Institute of Plasma Physics, Nagoya University, Nagoya, Japan). *Phys. Fluids;* **20**: No. 9, 1510-1515(Sep 1977).

Nonlinear propagation of externally driven waves in the lower hybrid frequency range in an inhomogeneous plasma are investigated. The results of finite temperature, inhomogeneity of the plasma, and density depression due to the ponderomotive force are emphasized since these effects are responsible for the propagation characteristics of the waves. The results show that the waves are localized in a spatial wave packet that propagates into the plasma center along the conical trajectory which makes a small angle with respect to the confining magnetic field.

57680 **Radiation coupling of Bernstein modes in a ring plasma.** Hoffman, J.M.; Aamodt, R.E. (Department of Astro-Geophysics, University of Colorado, Boulder, Colorado 80309). *Phys. Fluids;* **20**: No. 9, 1544-1550(Sep 1977).

Motivated by the observation of anomalously intense radiation at frequencies sharply peaked about the electron cyclotron harmonics, the behavior of high frequency flute modes in a weakly inhomogeneous magnetoplasma is investigated. The longitudinal approximation is eschewed and the coupling of Bernstein modes with electromagnetic modes is analyzed. A graphical method is described for visualizing the salient features of mode behavior in this inhomogeneous plasma, and a highly resonant coupling instability is proposed as the energy generating mechanism for the radiation.

57681 **Stability of a finite amplitude ion acoustic wave in plasmas.** Shukla, P.K. (Institut fuer Theoretische Physik, Ruhr-Universitaet Bochum, 4630 Bochum, Federal Republic of Germany). *Phys. Fluids;* **20**: No. 9, 1579-1580(Sep 1977).

The modulational instability of a finite amplitude ion-acoustic wave in the presence of trapped ions is considered. The wave is found to be stable.

57682 **Wave analysis of the tokamak drift mode.** Cheung, L. (Chairman Heights, Block A1, Eastbourne Road, Kowloon, Hong Kong). *Phys. Fluids;* **20**: No. 9, 1581-1582(Sep 1977).

Certain wave properties of large aspect ratio tokamak current-drift mode from the drift-kinetic equation by means of the expansion are studied. Using this small-inverse aspect ratio expansion, the wavefunction and the wave frequency-shift corrected to higher order have been systematically evaluated.

57683 **Backscatter and beam refraction in underdense gas breakdown with nanosecond CO_2 laser.** Burnett, N.H.; Baldis, H.A.; Enright, G.D.; Richardson, M.C.; Corkum, P.B. (National Research Council of Canada, Division of Physics, Ottawa, K1A OR6, Canada). *J. Appl. Phys.;* **48**: No. 9, 3727-3732(Sep 1977).

A 50-J 2-ns FWHM CO_2 laser pulse focused to intensities in excess of 10^{14} W/cm^2 has been used to induce breakdown in underdense He gas. The laser radiation scattered from these plasmas has been temporally and spectrally analyzed. It is observed that ion wave scattering can result in reflectivities in excess of 50% of the incident intensity. At filling pressures above 30 Torr the incident laser radiation is explosively refracted around the focal region by plasma formed a few mm upstream from focus thus quenching the high-intensity laser plasma interaction less than 1 ns subsequent to breakdown. A weak but well-defined line at 7.06 μm ($\omega = 3/2\ \omega_0$) was observed in the backscatter at filling pressures above 40 Torr.

57684 **Ponderomotive force and linear susceptibility in Vlasov plasma.** Cary, J.R.; Kaufman, A.N. (Physics Department and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **39**: No. 7, 402-404(15 Aug 1977).

We have obtained an exact, simple, and general relation between the second-order Hamiltonian, representing the ponderomotive force on the oscillation center of a particle in a high-frequency field, and the standard linear Vlasov susceptibility.

57685 **Electron cyclotron emission from the Princeton Large Tokamak.** Hosea, J.; Arunasalam, V.; Cano, R. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **39**: No. 7, 408-411(15 Aug 1977).

Experimental measurements of electron cyclotron emission from the Princeton Large Tokamak plasma reveal that blackbody emission occurs at the fundamental frequency. Such emission, not possible by direct thermal excitation of electromagnetic waves, is herein attributed to thermal excitation of electrostatic (Bernstein) waves which then mode convert into electromagnetic waves. The local feature of the electrostatic wave generation permits spatially and temporally resolved measurements of electron temperature as for second-harmonic emission.

57686 **Upper-hybrid-resonance absorption of laser radiation in a magnetized plasma.** Grebogi, C.; Liu, C.S.; Tripathi, V.K. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Rev. Lett.;* **39**: No. 6, 338-341(8 Aug 1977).

A magnetic field in a laser-irradiated plasma is shown to have an important effect on the resonant absorption of the laser radiation normally incident on the inhomogeneous plasma. For typical parameters in laser-fusion experiments, the absorption coefficient is above 50% with α equivalent $\pi^2(\omega/\omega_{pe})^2(L\omega/c)^{4/3}$ between 1.5 and 10 and a maximum of $\sim$70% is achieved for $\alpha = 4$.

FUSION POWER PLANTS

REFER ALSO TO CITATION(S) 56390, 57634

57687 (STI/PUB—439(Vol.1)) **Plasma physics and controlled nuclear fusion research, 1976. Nuclear fusion, supplement 1977. Volume I.** (International Atomic Energy Agency, Vienna (Austria)). 1977. 626p. (CONF-761012—P1). IAEA $44.00.

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, German, Federal Republic of (F.R. Germany) (6 Oct 1976).

This volume contains 50 papers that are given according to the following sessions: (1) tokamak experiment, (2) inertial confinement, and (3) high-beta plasmas. (MOW)

57688 (STI/PUB—439(Vol.2)) **Plasma physics and controlled nuclear fusion research, 1976. Nuclear fusion, supplement 1977. Volume II.** (International Atomic Energy Agency, Vienna (Austria)). 1977. 649p. (CONF-761012—P2). IAEA $45.00.

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, German, Federal Republic of (F.R. Germany) (6 Oct 1976).

This volume contains 54 papers on tokamak theory, plasma heating by particle and laser beams, tokamak experiments, low-beta toroidal plasma, and high-beta plasma. (MOW)

57689 (STI/PUB—439(Vol.3)) **Plasma physics and controlled nuclear fusion research, 1976. Nuclear fusion, supplement 1977. Volume III.** (International Atomic Energy Agency, Vienna (Austria)). 1977. 614p. (CONF-761012—P3). IAEA $43.00.

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, German, Federal Republic of (F.R. Germany) (6 Oct 1976).

This volume contains 48 papers on plasma heating, high-beta plasma, open traps, reactor design, focus, liner, and wall containment. (MOW)

57690 (UCRL—79548) **Review of the mirror hybrid reactor.** Bender, D.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 May 1977. Contract W-7405-ENG-48. 45p. (CONF-770350—1). Dep. NTIS, PC A03/MF A01.

From US/USSR workshop on hybrid reactor design; Moscow, Union of Soviet Socialist Republics (USSR) (14 Mar 1977).

The interim status of the reference mirror hybrid reactor design being performed by LLL and General Atomic is summarized. The reactor parameters have been chosen to minimize the cost of producing fissile fuel for consumption in fission power reactors. The design draws on the experience developed at LLL in previous hybrid reactor conceptual designs and on GA expertise in gas-cooling technology and fission reactor mechanical design.

57691 (UCRL—79600) **Magnetic fusion energy.** McNamara, B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Jun 1977. Contract W-7405-ENG-48. 51p. Dep. NTIS, PC A04/MF A01.

A brief review of fusion research during the last 20 years is given. Some highlights of theoretical plasma physics are presented. The role that computational plasma physics is playing in analyzing and understanding the experiments of today is discussed. The magnetic mirror program is reviewed. (MOW)

57692 **Nuclear fusion: focus on tokamak.** Steiner, D. (Oak Ridge National Lab., TN). *IEEE Spectrum;* **14**: No. 7, 32-38(Jul 1977).

The general aspects of fusion power systems, as well as some approaches to their development, are addressed from the viewpoints of engineering and technology. Focussing on a conceptual fusion power plant design, topics such as structure, materials, and maintenance, as well as environmental, safety, and economic factors, are dealt with. Still, in common with all such large-scale undertakings that try to project into the future, fusion power has built-in uncertainties. In this case, they are primarily in the area of plasma physics performance. Within the next five to six years, however, these uncertainties should be resolved and a national commitment could be made to a plan for demonstrating commercial feasibility in this century with a reasonable expenditure of money.

57693 **Recent developments in the design of conceptual fusion reactors.** Ribe, F.L. (Los Alamos Scientific Lab., NM). *Nucl. Technol.;* **34**: No. 2, 179-208(Jul 1977).

Since the first round of conceptual fusion reactor designs in 1973 - 1974, there has been considerable progress in design improvement. Two recent tokamak designs of the Wisconsin and Culham groups, with increased plasma beta and wall loading (power density), lead to more compact reactors with easier maintenance. The Reference Theta-Pinch Reactor has undergone considerable upgrading in the design of the first wall insulator and blanket. In addition, a conceptual homopolar energy storage and transfer system has been designed. In the case of the mirror reactor, there are design changes toward improved modular construction and ease of handling, as well as improved direct converters. Conceptual designs of toroidal-multiple-mirror, liner-compression, and reverse-field pinch reactors are also discussed. A design is presented of a toroidal multiple-mirror reactor that combines the advantages of steady-state operation and high-aspect ratio. The liner-compression reactor eliminates a major problem of radiation damage by using a liquid-metal first wall that also serves as a neutron-thermalizing blanket. The reverse-field pinch reactor operates at higher beta, larger current density and larger aspect ratio than a tokamak reactor. These properties allow the possibility of ignition by ohmic heating alone and greater ease of maintenance.

57694 **Role of TFTR.** Grace, J.N. (Energy Research and Development Administration, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 3(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57695 **Role of the TFTR in the development of tokamak physics.** Furth, H.P. (Princeton-Plasma Physics Lab., NJ). *Trans. Am. Nucl. Soc.;* **26**: 3-4(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57696 **TFTR: an overview.** Reardon, P.J. (Princeton-Plasma Physics Lab., NJ). *Trans. Am. Nucl. Soc.;* **26**: 4-5(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57697 **Industrial subcontractor team looks at TFTR.** Foust, O.J. (Ebasco Services Inc., Princeton, NJ). *Trans. Am. Nucl. Soc.;* **26**: 5-6(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57698 **Physics/engineering interface on the Tokamak Fusion Test Reactor Project.** Stern, E. (Grumman Aerospace Corp., Bethpage, NY). *Trans. Am. Nucl. Soc.;* **26**: 6-7(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57699 **Economic analysis of commercial fusion power.** Kostoff, R.N. (Energy Research and Development Administration, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 42(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57700 **Economic approaches to long-term energy source selection.** Hazelrigg, G.A. Jr. (ECON, Inc., Princeton, NJ). *Trans. Am. Nucl. Soc.;* **26**: 42-43(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57701 **Energy supply system modeling.** Deonigi, D.E. (Battelle Pacific Northwest Lab., Richland, VA). *Trans. Am. Nucl. Soc.;* **26**: 43(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57702 **Potential need for fusion in the U.S. energy system.** Beardsworth, E.; Powell, J.R. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 43-44(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57703 **Standard fusion reactor costing methods.** Young, J.R. (Battelle Pacific Northwest Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* **26**: 44-45(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57704 **Cost components of fusion plant design.** Aronstein, R.E.; Ghose, S.K. (Bechtel Power Corp., San Francisco). *Trans. Am. Nucl. Soc.;* **26**: 45(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57705 Impact of major design parameters on economics of Tokamak Power Plants. Abdou, M.A.; Brooks, J.N.; Dennis, C. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 46-47(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57706 TNS scoping studies. Grauman, D.W. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **26**: 47-48(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57707 Parametric design study of Tandem Mirror Fusion Reactors. Carlson, G.A. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.;* **26**: 48-49(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57708 Parametric and economic analysis of tokamak reactors with elongated plasmas. Bourque, R.F. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **26**: 49(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57709 Energetics assessment of the potential of the fusion-fission hybrid reactor system. Jonzen, M.R. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **26**: 50-52(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57710 Optimization process in the PPL hybrid study. Bathke, C.G. (Princeton-Plasma Physics Lab., NJ). *Trans. Am. Nucl. Soc.;* **26**: 52(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57711 Approaches to small-size field-reversed mirror reactors. Miley, G.H.; Driemeyer, D. (Univ. of Illinois, Urbana, IL). *Trans. Am. Nucl. Soc.;* **26**: 53-54(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57712 Mechanical design aspects of a Tandem Mirror Fusion Reactor. Neef, W.S. JR. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.;* **26**: 54-55(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57713 Reference mirror hybrid fusion-fission reactor design. Bender, D.J. (Univ. of California, Livermore); Lee, J.D.; Neef, W.S. *Trans. Am. Nucl. Soc.;* **26**: 55-56(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57714 ELMO Bumpy Torus Reactor (EBTR) reference design study. Uckan, N.A. (Oak Ridge National Lab., TN); Bettis, E.S.; Hedrick, C.L.; Santoro, R.T.; Yeh, H.T.; McAlees, D.G. *Trans. Am. Nucl. Soc.;* **26**: 57-58(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57715 MAXAMAK and MULTIMAK: new approaches for tokamak power reactors. Powell, J.R.; Lehner, J.; Hsieh, S.Y. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 58-59(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57716 Detailed design features of a high-field compact tokamak reactor (HFCTR). Cohn, D.R. (Massachusetts Inst. of Tech., Cambridge); Cook, D.; Herring, S. *Trans. Am. Nucl. Soc.;* **26**: 60-61(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57717 Impact of key plasma parameters on tokamak reactor designs. Ehst, D. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 83(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57718 Engineering considerations of the toroidal magnet and dewar for UWMAK. II. A Wisconsin Tokamak fusion reactor design. Sviatoslavsky, I.N.; Young, W.C.; Lue, J.W. (Univ of Wis, Madison). *Adv. Cryog. Eng.;* **21**: 78-87(1975).

From Cryogenic engineering conference; Kingston, Ontario, Canada (22 Jul 1975).

This paper describes the toroidal magnet and its cryogenic system. Optimization studies seem to indicate that a typical Tokamak power reactor will have a thermal output of 5000 MW, a major radius of 13 m, and a minor radius of 5 m. The D-shaped superconductive toroidal field magnets for such a reactor will probably have a bore of 25 m. Radiation damage to the plasma containment vessel will require its periodic replacement by remote control. 3 refs.

PHYSICS AND BLANKET ENGINEERING

REFER ALSO TO CITATION(S) 57812

57719 First wall thermal—mechanical analyses of the reference theta-pinch reactor. Krakowski, R.A.; Hagenson, R.L.; Cort, G.E. (Los Alamos Scientific Lab., NM). *Nucl. Technol.;* **34**: No. 2, 217-241(Jul 1977).

The thermal-mechanical response of the Reference Theta-Pinch Reactor (RTPR) first wall was analyzed. The first wall problems anticipated for a pulsed, high-β fusion power plant can be ameliorated by either alterations in the physics operating point, materials reengineering, or blanket/first wall reconfiguration. Within the latter "configuration" scenario, a two-fold approach has been adopted for the thermal-mechanical portion of the RTPR first wall technology assessment. First, a number of new first wall configurations (bonded or unbonded laminated composites, all-ceramic structures, protective and/or sacrificial "bumpers") were considered. Second, a more quantitative failure criterion, based on the developing theories of fracture mechanics, was identified. For each first wall configuration, transient heat transfer and thermoelastic stress calculations have been made. Two-dimensional finite element structural analyses have been made for a variety of mechanical boundary conditions. Only the Al_2O_3/Nb - 1 Zr system has been considered. The results of this study indicated a wide range of design solutions to the pulsed thermal stress problem anticipated for the RTPR.

57720 Measurements of the concentrations of impurities in tokamaks. Isler, R.C. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 16(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57721 Low Z/sub eff/ tokamak operation. Parker, R.R. (Massachusetts Inst. of Tech., Cambridge). *Trans. Am. Nucl. Soc.;* **26**: 17(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57722 Divertors for impurity control in tokamaks. Meade, D.M. (Princton-Plasma Physics Lab., NJ). *Trans. Am. Nucl. Soc.;* **26**: 18(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57723 Laboratory sputtering studies in fusion research. Smith, J.N. Jr. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **26**: 18(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57724 Impurity models for tokamaks. Hogan, J.T. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 18-20(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57725 Low maintenance, low pressure, low radioactivity graphite blanket concept for fusion reactors. Sze, D.K. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.;* **26**: 35(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57726 High-Z spectral shifter in a fusion reactor. Gohar, Y.; Maynard, C.W. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.;* **26**: 36-37(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57727 Catalyzed D-D and D-^{3}He fusion blanket designs. Fillo, J.A.; Powell, J.R.; Lazareth, O. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 37-38(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57728 Parameter matching for the breeding blanket. Gordon, C.W.; Harms, A.A. (McMaster Univ., Hamilton, Ontario). *Trans. Am. Nucl. Soc.;* **26**: 38-39(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57729 Thermal-hydraulic and neutronics analysis of an SAP-thermosyphon blanket. Fillo, J.A.; Powell, J.R.; Lazareth, O. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 39(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57730 Fusion blanket first-wall time-dependent thermal stress model. Fillo, J.A.; Majumdar, D.; Makowitz, H. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 40-41(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

MAGNET COILS AND FIELDS

57731 (COO—2780-3) Lateral buckling and vibrations of superconducting magnets for magnetic fusion reactors. Progress report, October 1976—May 1977. Moon, F.C. (Cornell Univ., Ithaca, N.Y. (USA). Dept. of Theoretical and Applied Mechanics). May 1977. Contract EY-76-S-02-2780. 24p. Dep. NTIS, PC A02/MF A01.
The main results center around experimental buckling results obtained in a 16 coil superconducting torus. This device is a $^1/_{75}$th model of an early Argonne National Lab experimental power reactor design. The coils in the experimental torus were designed to buckle below the normal transition current level. Up to 130 KA-turns were placed in the torus during these tests. The test results are described. (MOW)

57732 Safety of large fusion magnet systems. Powell, J.R. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 24-25(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57733 Kinetic energy release in missile ejection from confining magnets. Grzesik, J. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **26**: 34(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57734 Computational model for predicting the characteristics of a superconducting magnet. Turner, L.R.; Abdou, M.A. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 75-76(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57735 Conceptual demountable TF magnet design for UWMAK-II fusion reactor. Hsieh, S.Y.; Lehner, J.; Powell, J. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 76-78(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57736 Advantages of nonuniform current density distribution in an ohmic heating coil. Dalessandro, J.A.;. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **26**: 78(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57737 Positional instabilities of a plasma in a tokamak with a magnetic limiter. Ninomiya, H.; Suzuki, Y.; Kameari, A. (Jpn At Energy Res Inst, Tokai-mura). *Jpn. J. Appl. Phys.;* **15**: No. 11, 2201-2210(Nov 1976).
The stability conditions of a plasma with respect to its rigid vertical displacement and horizontal expansion are numerically studied for a tokamak with magnetic limiters. The stability regions are discussed in terms of the decay index n of the equilibrating vertical field at the center of the plasma cross section. The plasma is stable up to n=2.32 for the horizontal expansion even when a magnetic limiter is located in the outer side of the plasma cross section. For the vertical displacement, the plasma is stable even if n=-1.16 when magnetic limiters exist in the upper and lower sides of the plasma cross section. These results indicate that the uniformly displaced plasma is stabilized by the existence of the auxiliary coils, because the current flowing in the coils makes curvature of the magnetic field lines convex to the plasma. 9 refs.

57738 Cryogenic instrumentation needs in the controlled thermonuclear research program. Walstrom, P.L. (Oak Ridge Natl Lab, Tenn). *Adv. Instrum.;* **31**: 10(1976).
From 31. annual ISA conference; Houston, TX, USA (10 Oct 1976).
Monitoring of magnet system performance in fusion power reactors is discussed. Measured quantities may include temperature, strain, deflection, coil resistance, helium coolant pressure and flow, current, voltages, etc. The test environment, which includes high magnetic fields (up to 8-10 T) and low temperature, makes many commercial measuring devices inoperative or at least inaccurate. In order to ensure reliable measurements, careful screening of commercial devices for performance in the test environment is required. A survey of potentially applicable instrumentation is presented along with available information on operation in the test environment based on experimental data or on analysis of the physical characteristics of the device. Areas where further development work is needed are delineated. 24 refs.

57739 Superconducting toroidal field magnets for a tokamak engineering test reactor. Lue, J.W.; Conn, R.W. (Univ of Wis, Madison). *Adv. Cryog. Eng.;* **21**: 41-50(1975).
The design and the components of a superconducting toroidal field magnet for a TETR are described in this paper. The entire assembly consists of eighteen cryogenically stabilized superconducting coils evenly spaced around a central support structure. This structure, which also houses the transformer coils, is kept at liquid helium temperature so that low thermal loss to the magnet is possible. The individual helium inner dewar is tightly built around each coil. A secondary vacuum wall for the plasma is built in between the coils. 10 refs.

57740 Applications of superconducting magnets to energy with particular emphasis on fusion power. Komarek, P. (Kernforschungszentrum, Karlsruhe, Ger). *Adv. Cryog. Eng.;* **21**: 115-139(1975).
A survey is presented indicating which energy conversion systems can or must include superconducting windings, which characteristics can be specified for the magnets in the different conversion systems, and what is the present state of the art, as indicated by the largest prototype or experimental precursor. This tabulation indicates that industrial applications for magnets of homopolar machines and possibly for MHD generators are the only ones that are close to commercialization. 65 refs.

POWER SUPPLIES AND CIRCUITRY

57741 Economic feasibility of a fusion-based energy storage system. Hwang, W.G.; Parish, T.A. (Univ. of Texas, Austin). *Trans. Am. Nucl. Soc.;* **26**: 49-50(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57742 Electrical breakdown and tracking characteristics of pulsed high voltages in cryogenic helium and nitrogen. Haarman, R.A.; Williamson, K.D. Jr. (Univ of Calif, Los Alamos Sci Lab, NM). *Adv. Cryog. Eng.;* **21**: 102-108(1975).
The use of superconducting energy storage systems has become of interest in the past few years as a possible solution to the large energy-storage requirements in a pulsed-type fusion reactor such as the proposed SFTR (Scyllac Fusion Test Reactor) at Los Alamos Scientific Laboratory. In these systems rather large voltage pulses are imposed on components as a result of associated electrical circuitry, which includes the superconducting energy system. The object of this study was to provide design data for a large research fusion reactor system where maintenance and in-place modifications are expected to occur and the optimization of dielectric spacing is not always the prime consideration. 10 refs.

COOLING SYSTEMS

57743 Blanket cooling under accident conditions in fusion-fusion hybrid power reactors. Ullman, A.Z. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **26**: 30-31(Jun 1977).
From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57744 Loss-of-coolant accidents in lithium-cooled fusion blankets. Ferrell, W.L.; Chan, C.K.; Kastenberg, W.E. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **26**: 32-33(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57745 Accidental criticality of fusion/fission hybrid blanket designs. Badham, V.; Pomraning, G.C.; Kastenberg, W.E.; Okrent, D. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **26**: 33-34(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57746 Conduction-cooled minimum activity blankets for TNS and EPR fusion reactors. Lazareth, O.; Yu, W.S.; Powell, J. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 35-36(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57747 Liquid—lithium waterfall inertial confinement fusion reactor concept. Maniscalco, J.A.; Meier, W.R. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.;* **26**: 62-63(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

FUEL SYSTEMS

57748 Comparative breeding characteristics of fusion and fast reactors. Fortescue, P. (General Atomic Co., San Diego, CA). *Science;* **196**: No. 4296, 1326-1329(17 Jun 1977).

Expressions are developed to allow ready comparison of a hybrid fission-fusion plant and a fast breeder with respect to the number of thermal reactors that their fissile production could support, both for their feed requirements and for the new inventory needs of an expanding industry. These relations are expressed in terms of the neutron multiplication factor obtained in the fusion blanket, and the analogous quantities represented by the conversion ratios of the fast and thermal fission associated with the comparison. Results are presented graphically both for the steady state and for industries of arbitrary growth rate, and include the influence of tritium production requirements. Even a modest blanket neutron multiplication factor could enable the hybrid fusion system greatly to outperform the fast breeder on this simple basis of material balances.

57749 Fueling problem. Gralnick, S.L. (Princton-Plasma Physics Lab., NJ). *Trans. Am. Nucl. Soc.;* **26**: 12(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57750 Fueling by high-speed pellet injection. Foster, C.A. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 12-13(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57751 Fueling of toroidal plasmas by ripple-assisted injection of energetic particles. Jassby, D.L. (Princeton-Plasma Physics Lab., NJ). *Trans. Am. Nucl. Soc.;* **26**: 13-14(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57752 D-^{3}He-fueled tokamak power reactors. Southworth, F.H. (Univ. of Illinois, Urbana). *Trans. Am. Nucl. Soc.;* **26**: 59-60(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57753 Tritium systems test assembly at Los Alamos Scientific Laboratory. Sherman, R.H.; Bartlit, J.R.; Anderson, J.L. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **26**: 72(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57754 Computation of specific thermonuclear reaction rates: the STEEP Code. Dei, D.A. (Carnegie-Mellon Univ., Pittsburgh); Husseiny, A.A.; Hale, G.M. *Trans. Am. Nucl. Soc.;* **26**: 80-81(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

RADIATION HAZARDS

REFER ALSO TO CITATION(S) 56651

57755 (EPRI-ER—451(Vol.1)(5-77)) **Fusion-driven actinide burner design study. Final report.** Rose, R.P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). May 1977. 316p. Dep. NTIS, PC A14/MF A01.

The principal characteristics of a beam driven tokamak fusion-fission hybrid reactor for actinide depletion have been developed in this design study. Based on mid-to-late 1980's technology, this reactor provides a fusion neutron wall loading of approximately 1 MW/m^2 corresponding to approximately 10^{14} n/cm^2-sec in the 14 MeV energy range. The blanket is fueled with residual actinides contained in the high level waste from the LWR-U cycle. These residual actinides are the only fissionable material contained in the fast helium cooled blanket lattice and provide sufficient neutron multiplication to give neutron fluxes in the range of 10^{15} n/cm^2-sec. A principal result of the study has been the development of a revised criterion for assessing long term radiotoxic hazard potential from the actinides. This index relates hazard potential from the waste to that of the naturally occurring parent uranium ore from which the wastes were produced. Volume 1 contains the following chapters: (1) fusion driver, (2) fissionable blanket design, (3) nuclear design and analysis, and (4) long term decay analysis and hazard evaluation.

57756 (EPRI-ER—451(Vol.2)(5-77)) **Fusion-driven actinide burner design study. Final report.** Rose, R.P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). May 1977. 355p. Dep. NTIS, PC A16/MF A01.

The principal characteristics of a beam driven tokamak fusion-fission hybrid reactor for actinide depletion have been developed in this design study. Based on mid-to-late 1980's technology, this reactor provides a fusion neutron wall loading of approximately 1 MW/m^2 corresponding to approximately 10^{14} n/cm^2-sec in the 14 MeV energy range. The blanket is fueled with residual actinides contained in the high level waste from the LWR-U cycle. These residual actinides are the only fissionable material contained in the fast helium cooled blanket lattice and provide sufficient neutron multiplication to give neutron fluxes in the range of 10^{15} n/cm^2-sec. A principal result of the study has been the development of a revised criterion for assessing long term radiotoxic hazard potential from the actinides. This index relates hazard potential from the waste to that of the naturally occurring parent uranium ore from which the wastes were produced. Volume II contains the following chapters: (1) materials technology, (2) thermal and hydraulic design, (3) reactor support systems and balance of plant, (4) environmental and safety considerations, (5) scoping estimates of system cost, and (6) development requirements.

57757 Overview of the MFE/ERDA Environment and Safety Program. Baublitz, J.E. (Energy Research and Development Administration, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 21(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57758 Tritium containment and cleanup technology in the Tritium Systems Test Assembly. Anderson, J.L. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **26**: 21-22(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57759 Biological implications of magnetic fields from fusion reactors. Mahlum, D.D. (Battelle Pacific Northwest Lab., Richland, VA). *Trans. Am. Nucl. Soc.;* **26**: 22(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57760 Some perspective on tritium permeation in fusion reactors based on existing data and experience. Maroni, V.A. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 22-24(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57761 Safety studies of second-generation fusion reactor designs. Okrent, D.; Kastenberg, W.E.; Chan, C.K.; Frederking, T.H.K.; Pomraning, G.C.; Ullman, A.Z. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **26**: 25-26(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57762 Waste management procedures for CTR central power stations. Botts, T.; Powell, J.R. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 28-29(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57763 Tritium health effects during normal and off-normal release in CTRs. McKone, T.E.; Kastenberg, W.E.; Ullman, A.Z. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **26**: 29-30(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57764 Preliminary assessment of potential accidents of laser fusion electric generation stations. Devaney, J.; Booth, L.; Pendergrass, J.; Frank, T. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **26**: 31-32(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57765 Mathematical models for transport of tritium and helium-4 in solid breeders. Alire, R.M.; Steward, S.A.; Deutscher, S.B. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.;* **26**: 75(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

INERTIAL CONFINEMENT SYSTEMS

REFER ALSO TO CITATION(S) 57284, 57285, 57286, 57657, 57676, 57764

57766 (AD-A—037761) **Experimental simulation of parametric instabilities in laser-plasma interactions. Interim report.** Luhmann, N.C. Jr. (California Univ., Los Angeles (USA). Dept. of Electrical Sciences and Engineering). Nov 1976. Contract F49620-76-C-0012. 43p. NTIS PC A03/MF A01.

Paper presented at the U.S.-Japan Seminar on Laser Interactions with Matter, 2-5 Nov. 76, Rochester, N. Y.

There is currently a great interest in the mechanisms by which intense electromagnetic radiation interacts with plasmas. A major impetus for this interest has been the laser-pellet fusion program. The process whereby the incident electromagnetic wave gives up energy to the plasma can be much more complex than simple binary collisional damping by electronion collisions. (Author)

57767 (COO—2007-82) **Laser-fusion concept using D-D-T pellets with the DNP laser feedback system.** Miley, G.H.; Sutherland, S.; Choi, C.; Glowienka, J. (Illinois Univ., Urbana (USA)). 1977. Contract EY-76-S-02-2007. 4p. (CONF-770629—4). Dep. NTIS, PC A02/MF A01.

From Conference on laser engineering and applications; Washington, District of Columbia, United States of America (USA) (1 Jun 1977).

A laser-fusion reactor employing deuterium rich pellets to produce 2.45- and 14-MeV neutron pumping of a direct-nuclear-pumped laser (DNPL) is considered. Neutronic calculations indicate feedback operation (i.e., DNPL-driven implosion) is feasible, but developmental problems remain.

57768 (NRL-MR—3525) **Optical pulse squaring effects in a dispersive delay line.** Lehmberg, R.H.; Reintjes, J.; Eckardt, R.C. (Naval Research Lab., Washington, D.C. (USA)). May 1977. 12p. Dep. NTIS, PC A03/MF A01.

Using a pair of diffraction gratings, temporal squaring effects were produced on 30 psec-duration 1.06 μm pulses that were negatively self phase modulated in cesium vapor. The results are in good agreement with the theory, which is discussed in detail. Further enhancement of the squaring by a saturable absorber is also discussed.

57769 (UCRL—13720) **Laser fusion hybrid reactor systems study.** (Bechtel Corp., San Francisco, Calif. (USA)). Jul 1976. Contract W-7405-ENG-48;PO-8777205. 114p. Dep. NTIS, PC A06/MF A01.

The work was performed in three phases. The first phase included a review of the many possible laser-reactor-blanket combinations and resulted in the selection of a "demonstration size" 500 MWe plant for further study. A number of fast fission blankets using uranium metal, uranium-molybdenum alloy, and uranium carbide as fuel were investigated. The second phase included design of the reactor vessel and internals, heat transfer system, tritium processing system, and the balance of plant, excluding the laser building and equipment. A fuel management scheme was developed, safety considerations were reviewed, and capital and operating costs were estimated. Costs developed during the second phase were unexpectedly high, and a thorough review indicated considerable unit cost savings could be obtained by scaling the plant to a larger size. Accordingly, a third phase was added to the original scope, encompassing the redesign and scaling of the plant from 500 MWe to 1200 MWe (less lasers).

57770 (UCRL—13735-2) **Polarized particle levitation in hexapole field.** Jones, T.B.; Kallio, G.A.; Robinson, K.S. (Colorado State Univ., Fort Collins (USA). Dept. of Electrical Engineering). Jun 1976. Contract W-7405-ENG-48. 47p. Dep. NTIS, PC A03/MF A01.

Proposed here is a novel electrostatic levitation scheme which uses the force exerted by a non-uniform electric field on a polarized particle. The scheme differs from conventional quadrupole levitation devices principally in that the levitated particle is uncharged. In order to provide the proper force required to achieve dynamic stabilization, a very intense non-uniform time-varying electric field produced by a three-dimensional hexapole electrode structure is utilized. The primary advantage of this levitation scheme might accrue in target fabrication operations where particle charge is undesirable or where reproducible charging of the particles themselves is difficult, due to high resistivity. The disadvantages of this scheme, as compared to charged particle levitation, are (i) a more complex electrode structure and (ii) significantly higher voltages. The scheme has possible application to molecular mass spectrometry, in situations where un-ionized but strongly polar or polarizable molecules are to be trapped or confined for analysis.

57771 (UCRL—79540) **Laser fusion implosion and target interaction physics.** Ahlstrom, H.G.; Nuckolls, J.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 May 1977. Contract W-7405-ENG-48. 14p. (CONF-770629—5). Dep. NTIS, PC A02/MF A01.

From Conference on laser engineering and applications; Washington, District of Columbia, United States of America (USA) (1 Jun 1977).

Laser plasma experiments at the Lawrence Livermore Laboratory have progressed very rapidly and have achieved new milestones in both the implosion and DT gain in laser fusion targets. New diagnostic methods were also developed for determining the state of the compressed fuel and the plasma processes which are occurring in the absorption and scattering of the laser light incident on the laser fusion pellets. A review of the program is given. (MOW)

57772 (UCRL—79628) **Theoretical interpretation of angle- and polarization-dependent laser light absorption measurements.** Thomson, J.J.; Kruer, W.L.; Langdon, A.B.; Max, C.E.; Mead, W.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Jun 1977. Contract W-7405-ENG-48. 11p. (CONF-770571—2). Dep. NTIS, PC A02/MF A01.

From Anomalous absorption conference; Vancouver, British Columbia, Canada (10 May 1977).

It was shown that recently published observations of angle- and polarization-dependent absorption of intense laser light are consistent with computer simulations of resonance absorption in a steepened plasma profile, with the addition assumption of a modestly rippled critical surface. About 10 percent absorption seems to be due to mechanisms not addressed in the simulations.

57773 Inertial confinement fusion program. Schriever, R.L. (Energy Research and Development Administration, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 8(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57774 Inertial confinement fusion reactor and generating station concepts. Frank, T.G.; Booth, L.A. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **26**: 8-9(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57775 Laser fusion technology and experiments. Maniscalco, J.A. (Univ. of California, Livermore); Monsler, M.J. *Trans. Am. Nucl. Soc.;* **26**: 9(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57776 Electron-beam technology and electron-beam target experimental results. Toepfer, A.J. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.;* **26**: 9-10(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57777 Potential for ion-beam fusion. Teng, L.C. (Fermi National Accelerator Lab., Batavia, IL). *Trans. Am. Nucl. Soc.;* **26**: 10-11(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57778 Conceptual approach to laser fusion hybrid reactor. Holman, R.R.; Kovacik, W.P. (Westinghouse Advanced Energy Systems Div., Pittsburgh). *Trans. Am. Nucl. Soc.;* **26**: 56-57(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57779 Comparative study of exploratory reactor concepts for inertial confinement fusion. Maniscalco, J.A.; Meier, W.R. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.;* **26**: 62(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57780 Reactor considerations of ion beam-pellet fusion. Campbell, R.B.; Kammash, T. (Univ. of Michigan, Ann Arbor). *Trans. Am. Nucl. Soc.;* **26**: 63-64(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57781 First wall and blanket design for an ICTR. Abdel-Khalik, S.I.; Conn, R.W. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.;* **26**: 66-68(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57782 Heat transfer and stress problems associated with ICTR walls. Abdel-Khalik, S.I.; Lovell, E.G.; Hunter, T.O.; Hejazi, M. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.;* **26**: 68-69(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57783 Radiation patterns from electron beam fusion targets. Freeman, J.R. (Sandia Lab, Albuquerque, NM). *IEEE Trans. Plasma Sci.;* **PS-4**: No. 3, 194-198(Sep 1976).

Time-integrated x-ray pinhole photographs of gold spheres and hemispheres irradiated by focused intense relativistic electron beams have exhibited radiation patterns with a distinct, brightened edge or halo. This report describes Monte Carlo electronphoton transport calculations which were performed to analyze this halo effect. A locally 1-D model of the spherical targets is presented and is used to obtain information concerning the spectral variation of the radiation pattern. These results indicate that a complete model, including film response and effective pinhole size, is required for proper quantitative comparison. 12 refs.

57784 Three-dimensional structure of the spread of laser-produced plasma consisting of aluminium ions and nuclei. Bykovskii, YW.A.; Kozyrev, Y.P.; Sil'nov, S.M.; Sharkov, B.Y. *Kvantovaya Elektron. (Moscow);* **1**: No. 3, 709-711(Mar 1974). (In Russian).

Published in summary form only; for English translation see the journal Sov. J. Quant. Electron.

COMPONENT DEVELOPMENT AND TESTING

REFER ALSO TO CITATION(S) 56652, 57108, 57134, 57155, 57497

57785 (BNL—22759) **Cryopumping of deuterium hydrogen and helium mixtures on smooth 4.2 K surfaces.** Chou, T.S.; Halama, H.J. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. vp. (CONF-770908—3). Dep. NTIS, PC A02/MF A01.

From 7. international Vac. congress and 3. international conference on solid surfaces; Vienna, Austria (12 Sep 1977).

The large quantities of deuterium and hydrogen to be pumped in a fusion reactor and its subsystems favor cryopumping over other pumping methods. Cryogen consumption and the operating pressure will not only depend on the gas to be pumped, but also on the amount of helium gas present in the system. In fact, residual helium pressure between pulses will determine the power dissipation of the pump, and hence, influence the choice of cryocondensation or cryosorption. In this paper we will present the results of our studies on (1) cryotrapping of helium in thick D_2 and H_2 films and hydrogen in D_2 films at 4.2 K; (2) diffusion of He and H_2 from D_2 films; (3) steady-state liquid helium consumption; (4) liquid helium consumption as a function of D_2 and H_2 fluxes being pumped; (5) liquid helium consumption as a function of He partial pressure in the system. Finally, these measurements will suggest maximum permissible He to D_2 and He to H_2 ratios in a cryocondensation pump.

57786 (COO—3028-28) **Radiolytic production of chemical fuels in fusion reactor systems.** Fish, J.D. (Princeton Univ., N.J. (USA)). Jun 1977. Contract EY-76-S-02-3028. 203p. Dep. NTIS, PC A10/MF A01.

Thesis.

Miley's energy flow diagram for fusion reactor systems is extended to include radiolytic production of chemical fuel. Systematic study of the economics and the overall efficiencies of fusion reactor systems leads to a criterion for evaluating the potential of radiolytic production of chemical fuel as a means of enhancing the performance of a fusion reactor system. The ecumenicity of the schema is demonstrated by application to (1) tokamaks, (2) mirror machines, (3) theta-pinch reactors, (4) laser-heated solenoids, and (5) inertially confined, laser-pellet devices. Pure fusion reactors as well as fusion-fission hybrids are considered.

57787 (COO—4093-1) **Radiation cleanup of vacuum systems (radiation-induced outgassing). Progress report, September 15, 1976—September 14, 1977.** Anno, J.N. (Cincinnati Univ., Ohio (USA)). Jun 1977. Contract EY-76-S-02-4093. 17p. Dep. NTIS, PC A02/MF A01.

A stainless steel-304 vacuum system has been designed and constructed to study radiation-induced outgassing when this material is exposed to cobalt-60 gamma radiation. The system is pumped with an ion pump and sorption roughing pump. No foreign materials have been introduced except for copper seals at the flanges. An analytical model has been developed which predicts the outgassing from SS-304 to be 8.27×10^{-12} torr-liters/(cm^2)(sec) per megarad/hr. Extrapolation of existing data for aluminum suggests a lower value of 1.0×10^{-12} torr-liters/(cm^2)(sec) per megarad/hr. Experiments to determine the value are currently in progress.

57788 (LA-UR—77-1033) **Neutron dosimetry at the intense neutron source (INS).** Dierckx, R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 13p. (CONF-770523—6). Dep. NTIS, PC A02/MF A01.

From Symposium on neutron cross sections 10-40 MeV; Upton, New York, United States of America (USA) (3 May 1977).

The neutron monitoring consists of two parts: the spectral characterization and the fluence determination. The experimental measurements are combined with theoretical calculations. The following methods are proposed for determining the spectra: a telescope (np) spectrometer, a telescope ^{6}Li(nα)T spectrometer, spectrometers needing unfolding, time-of-flight technique, and multiple foil technique. (MOW)

57789 New approach to assessing fusion plasma-materials interactions. Cafasso, F.; Gruen, D.; Kaminsky, M.; Robinson, J.E. (Argonne National Lab., IL). *Nucl. Technol.;* **34**: No. 2, 131-134(Jul 1977).

A method to determine the contributions to plasma contamination and to surface erosion arising from synergistic effects under multiple-component irradiation is discussed. Some examples of situations that are likely to give rise to synergistic phenomena are given. (MOW)

57790 Some interesting engineering problems in TFTR design. Bilton, J.R. (Ebasco Services Inc., Princeton, NJ). *Trans. Am. Nucl. Soc.;* **26**: 7(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57791 Minimizing long-term radioactivity in fusion reactors by isotopic tailoring. Conn, R.W. (Univ. of Wisconsin, Madison); Okula, K.; Johnson, W. *Trans. Am. Nucl. Soc.;* **26**: 27-28(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57792 DKR: a radioactivity calculation code and decay chain data library. Sung, T.Y.; Vogelsang, W.F. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.;* **26**: 39-40(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57793 Liquid-wall boiler and moderator (BAM) for heavy ion-pellet fusion reactors. Powell, J.; Lazareth, O.; Fillo, J. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 64-65(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57794 First-wall costs of an ion-beam fusion reactor. Hovingh, J. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.;* **26**: 65-66(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57795 Lifetime considerations for a fusion reactor first wall of type 316 stainless steel. Wolfer, W.G.; Conn, R.W. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.;* **26**: 69-70(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57796 Initial neutronic evaluation of imploding liner fusion reactor blankets for transmuting fission products. Parish, T.A.; Davidson, J.W. (Univ. of Texas, Austin). *Trans. Am. Nucl. Soc.;* **26**: 70-71(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57797 Cryosorption pumping of helium at 4.2 K by Type 5A molecular sieve. Fisher, P.W.; Watson, J.S. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 72-73(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57798 Cryopump, neutral-beam compatibility test. Berkner, K.H. (Univ. of California, Berkeley); Law, P.K.; Pyle, R.V.; Ruby, L.; Pittenger, L.C.; Valby, L.E. *Trans. Am. Nucl. Soc.;* **26**: 73-74(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57799 Assessment of uranium and cerium as hydriding materials for hydrogen isotopes in flowing argon. Singleton, M.F.; Folkers, C.L.; Griffith, C.M. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.;* **26**: 74-75(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57800 Modeling and analysis of impurity control techniques for tokamak fusion reactors. Stacey, W.M. Jr.; Brooks, J.N.; Smith, D.L. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 79-80(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57801 First-wall characterization of tokamaks by in situ auger electron spectroscopy. Dylla, H.F.; Cohen, S.A. (Princeton-Plasma Physics Lab., NJ). *Trans. Am. Nucl. Soc.;* **26**: 148-149(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

57802 Production of 14 MeV neutrons by heavy ions. Brugger, R.M.; Miller, L.G.; Young, R.C. (to Energy Research and Development Administration). US Patent 4,008,411. 15 Feb 1977. Filed date 8 Jul 1975. 8p.

PAT-APPL-594-166.

This invention relates to a neutron generator and a method for the production of 14 MeV neutrons. Heavy ions are accelerated to impinge upon a target mixture of deuterium and tritium to produce recoil atoms of deuterium and tritium. These recoil atoms have a sufficient energy such that they interact with other atoms of tritium or deuterium in the target mixture to produce approximately 14 MeV neutrons. 9 claims, 2 figures.

57803 Method and means of reducing erosion of components of plasma devices exposed to helium and hydrogen isotope radiation. Kaminsky, M.S.; Das, S.K.; Rossing, T.D. (to Energy Research and Development Administration). US Patent 4,004,890. 25 Jan 1977. Filed date 9 Feb 1976. 6p.

PAT-APPL-656,214.

Surfaces of components of plasma devices exposed to radiation by atoms or ions of helium or isotopes of hydrogen can be protected from damage due to blistering by shielding the surfaces with a structure formed by sintering a powder of aluminum or beryllium and its oxide or by coating the surfaces with such a sintered metal powder. 7 claims.

GENERAL AND MISCELLANEOUS

57804 Transactions of the American Nuclear Society 1977 annual meeting, New York, NY, June 12—16, 1977. Farmakes, R. (ed.). *Trans. Am. Nucl. Soc.;* **26**: 1-610(Jun 1977).

The individual summaries were indexed and title listed for appearance in ERA.

MANAGEMENT

REFER ALSO TO CITATION(S) 57088, 57817, 57818

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 55702, 55765, 55821, 55822, 57328, 57560

57805 (ANL-AMD-TM—191) **Some subroutines for producing captioned contour line plots and line graphs on film.** Wessel, W.R. (Argonne National Lab., Ill. (USA)). Feb 1970. Contract W-31-109-ENG-38. 42p. Dep. NTIS, PC A03/MF A01.

This report describes a group of subroutines, running on the IBM 360, that produce contour plots and line graphs on film by use of the 2280 Film Recorder. All subroutines are written in FORTRAN, and do not modify the user's input variables unless it is specifically stated otherwise. The use of these subroutines is described in sufficient detail that the average user should be able to use them immediately for ordinary contour plotting or line graph display. 13 figures.

57806 (ANL-AMD-TM—282(Rev.)) **Relationship between the BFGS and conjugate gradient algorithms.** Nazareth, L. (Argonne National Lab., Ill. (USA)). 1977. Contract W-7405-ENG-38. 13p. Dep. NTIS, PC A02/MF A01.

Based upon analysis and numerical experience, the BFGS algorithm is currently considered to be one of the most effective algorithms for finding a minimum of an unconstrained function, f(x), x an element of IR/sup n/. However, when computer storage is at a premium, the usual alternative is to use a conjugate gradient (CG) method. This paper shows that the two algorithms are related to one another in a particularly close way. Based upon these observations, a new family of algorithms is proposed.

57807 (ANL-AMD-TM—283(Rev.)) **Davidon's optimally conditioned algorithms for unconstrained optimization.** Nazareth, L. (Argonne National Lab., Ill. (USA)). 1976. Contract W-7405-ENG-38. 25p. Dep. NTIS, PC A02/MF A01.

Recently, Davidon [Math. Prog., 9, 1-30] has published some new and very promising algorithms for minimizing unconstrained functionals. A particular perspective on these algorithms is presented, and extensions of some of the theory underlying them are developed in this paper.

57808 (GA-A—14405) **MODSAP: a modified version of the program SAP IV for the static and dynamic response of linear and localized nonlinear structures.** Johnson, J.J. (General Atomic Co., San Diego, Calif. (USA)). Apr 1977. Contract EY-76-C-03-0167-051. 15p. (CONF-770621—2). Dep. NTIS, PC A02/MF A01.

From SAPuusers conference; Los Angeles, California, United States of America (USA) (20 Jun 1977).

The computer program MODSAP is an expanded and modified version of the program SAP IV, originally developed at the University of California, Berkeley. This paper outlines the expanded capabilities of MODSAP. 2 figs., 1 table.

57809 (K/CSD/TM—13) **Equating degrees of freedom in the SAP finite element code.** McGrath, S.V.; Schlemper, L.I. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). May 1977. Contract W-7405-ENG-26. 27p. Dep. NTIS, PC A02/MF A01.

A straightforward method of equating degrees of freedom in the SAP finite element code is discussed. Nodal displacements can be equated in either rectangular or cylindrical coordinate systems. The implementation of the method for two-dimensional elements is explicitly defined. 4 figures.

57810 (K/CSD/TM—14) **Installation of DSS/2 on the IBM 360/195 computer at K-25.** Lister, D.M. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). Jun 1977. Contract W-7405-ENG-26. 35p. Dep. NTIS, PC A03/MF A01.

The Differential Systems Simulator, Version 2(DSS/2), is a software package that can be used to solve sets of differential equations. This report discusses the work performed in implementing the package on the IBM 360/195 at K-25. It records the names of the data sets produced and the JCL procedures used. It is not intended as a detailed programer's guide for the installation of a system such as DSS/2. 7 figures, 2 tables.

57811 (LA-UR—77-894) **Queueing network models of computer systems with limited parallelism in subnetworks.** Keller, T.W. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1977. Contract W-7405-ENG-36. 16p. (CONF-770812—2). Dep. NTIS, PC A02/MF A01.

From International symposium on computer performance modeling, measurement, and evaluation; Yorktown Heights, New York, United States of America (USA) (16 Aug 1977).

The classic central server model of computer systems is extended by allowing more realistic I/O distributions and by the introduction of "passive" resources. When the number of passive resources is less than the number of processors in the I/O subnetwork of the model, the degree of parallelism obtainable in the subnetwork is restricted, with the result that I/O processes can block. Two computationally inexpensive decomposition techniques are presented which obtain approximate solutions to the model. The first makes the exponential assumption for a composite server approximating the properties of the subnetwork. The second, more accurate, method uses the results of Sauer to remove the exponential restriction on the composite server. The solution methods are applied to an extended central server model of a CDC 6000 series computer system in which the passive resources are a pool of peripheral processors which limit the number of I/O processes which may be active. An investigation of the accuracy of both methods is made over a wide range of realistic model parameters. The central server model, ignoring passive resources, results in unacceptable error. The first approximation method when applied to the extended model results in adequate accuracy in most cases. The second method results in good accuracy for all cases. 3 figures.

57812 (LA-UR—77-1345) **INGEN: a general purpose mesh generator for finite element codes.** Cook, W.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 23p. (CONF-770813—3). Dep. NTIS, PC A02/MF A01.

From ADINA conference; Cambridge, Massachusetts, United States of America (USA) (4 Aug 1977).

INGEN is a general purpose mesh generator for two- and three-dimensional finite-element codes. The basic parts of the code are surface and three-dimensional region generators that are linear-blending interpolation formulas. These generators are based on an i, j, k index scheme which is used to number nodal points, construct elements, and develop displacement and traction boundary conditions. 12 figures, 2 tables.

57813 (ORNL/CSD/TM—30) **Designs for the detection of inadequacy in factorial models.** Morris, M.D.; Mitchell, T.J. (Oak Ridge National Lab., Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 166p. Dep. NTIS, PC A09/MF A01.

In many experimental situations, a linear model of form y = f_1' (xi) β_1 + epsilon is assumed to describe the relationship between an "observed" variable, y, and a set of "controlled" variables, xi. Epsilon is a random variable with properties consistent with the Gauss—Markoff theorem. One concern is that this assumed model is adequate, extensive enough so as to accurately reflect the relationship between y and xi. The more extensive linear model, y = f_1' (xi) β_1 + f_2' (xi) β_2 + epsilon, can be supposed to be the true relationship between y and xi. Jones and Mitchell [UCC-ND-CSD-21 (1975)] developed the Λ_s design optimality criterion for use in selecting designs with relatively high power for detecting lack of fit in the assumed model due to non-zero β_2. The present study is concerned with the application of the Λ_s-criterion to designs for factorial experiments. In particular, main effects designs which are Λ_s-optimal for detecting two-factor interactions are investigated. An alternate motivation for use of the criterion is developed for 2/sup k/ factorial experiments. It is shown that optimality is invariant to selection of full-rank parameterization. Several Λ_s-optimal designs for 2/sup k/ and 3/sup k/ experiments are constructed by using computer search techniques. Optimal 2/sup k/ designs are found for experiments including up to eight factors and of size such that an orthogonal array of strength three cannot be constructed. Designs for 3^4, 3^5, and 3^6 experiments, in sizes for which orthogonal arrays of strength three do not exist, are also found. 24 tables, 45 references.

57814 (SAND—76-5572) **Computational solution of nonlinear two-point boundary-value problems.** Scott, M.R.; Watts, H.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 22p. (CONF-770914—1). Dep. NTIS, PC A02/MF A01.

From Symposium on computers in chemical engineering; Vysoke Tatry, Czechoslovakia (Sep 1977).

A working computer code, called SUPOR Q, which solves quite general nonlinear two-point boundary value problems is described. The nonlinear problem is replaced by a sequence of linear problems by applying quasilinearization (Newton's method) to the nonlinear differential operator. Each linear two-point boundary value problem is solved by an initial-value procedure which combines the well-known technique of superposition with a process called orthonormalization. 3 tables.

57815 (SU—326-P.39-19) **Emmy/Unibus interface design specification. Technical note No. 109.** Shih, M. (Stanford Univ., Calif. (USA). Digital Systems Lab.). Jan 1977. Contract EY-76-S-03-0326-039. 21p. Dep. NTIS, PC A02/MF A01.

The interface, named "MATCH" (a bus translation unit), is designed to allow communication between the Emmy system bus and a DEC PDP-11 Unibus. The translation unit consists of five functionally independent modules: an Emmy I/0 interface unit, an address translation unit, two-ported data path, a microprogramed translation sequencer, and a Unibus I/0 interface unit. The Emmy I/0 interface unit allows the Emmy system to act as bus master on the Unibus. The 32-bit Emmy bus address is truncated to 18 bits for use on the Unibus. The command field provides the control information for the transfer. The Unibus I/0 interface unit allows the Unibus device to act as master on the Emmy bus. The 18-bit Unibus address is mapped into the 24-bit Emmy address space through the address translation unit, where the command field is also generated. A mapping scheme is used which utilizes a page setup register file to associate dynamically one of fifty-four 2K halfword pages with a 1K fullword Emmy page. The microprogramed sequencer receives commands from the master unit on either bus system and provides all the sequence control for the specified operation. Data path is designed into two parts; one is the halfword part for most of the transfers, and the other, fullword part, is used mainly for transfer to/from the control store and other high-speed devices. The address translation facility provides mapping of pages in the Unibus address space other than the base pages (occupied by 4K core memory) and the upper pages which by convention are reserved for use as device registers. The entire address space of each bus system is available to the other system. 5 figures.

57816 (UCID—17090(Rev.1)) **User's guide to the LLL BASIC interpreter.** Allison, T.; Eckard, R.; Barber, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Jun 1977. Contract W-7405-ENG-48. 22p. Dep. NTIS, PC A02/MF A01.

Scientists are finding increased applications for microcomputers as process controllers in their experiments. However, while microcomputers are small and inexpensive, they are difficult to program in machine or assembly language. A high-level language is needed to enable scientists to develop their own microcomputer programs for their experiments on location. Recognizing this need, LLL contracted to have such a language developed. This report describes the result--the LLL BASIC interpreter, which operates with LLL's 8080-based MCS-80 microcomputer system. 4 tables.

57817 (UCID—30151) **FORMS: a generator of time-card forms.** Lai, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Mar 1977. Contract W-7405-ENG-48. 13p. Dep. NTIS, PC A02/MF A01.

The program FORMS aids in changing information on monthly employee time-card forms. FORMS is capable of extracting employee information and task numbers and descriptions from an appropriate TAT file and of editing the contained information. It may be instructed to generate one form per employee, one form per group, or individual forms for specified groups or employees. 2 figures.

57818 (UCID—30152) **MANAGER: a generator of reports on the expenditure of scientific manpower.** Lai, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Mar 1977. Contract W-7405-ENG-48. 36p. Dep. NTIS, PC A03/MF A01.

The computer program MANAGER accepts monthly data on how the time of scientists within a division is allocated, updates a year-to-year summary file, and generates reports that give current and cumulative figures on that allocation of effort. The reports subdivide this effort according to scientists, tasks, events, specific accounts, and accounts submitted to Laboratory accounting. The structure of the files, the instructions for executing MANAGER, and the procedures for storing files, punching cards, and generating reports are described. 7 figures.

57819 (UCLA—34P214-37) **Specialization of SARA for software synthesis.** Campos, I.M.; Estrin, G. (California Univ., Los Angeles (USA). Dept. of Computer Science). 1977. Contract EY-76-S-03-0034-214. 9p. (CONF-770211—5). Computer Society, Long Beach, CA.

From ACM/IEEE symposium on design automation and microprocessors; Palo Alto, California, United States of America (USA) (24 Feb 1977).

The SARA system was developed to permit topdown design without necessarily prespecifying that implementation would be done in software or hardware. It was felt very important to give the designer freedom to make that decision at a late stage and therefore select the appropriate place for the hardware—software interface. However, the synthesis methodology does not force the designer to hide an intention to use particular devices or particular software systems. Moreover, the area in greatest need of design assistance is programing where a language and associated virtual or real machine would already have been selected. Hence the question was raised, "What specialization of SARA would be important for the synthesis of software systems." This paper discusses models of software systems under two very different conditions. In one, it is known that the design of a program for a sequential PL/I processor raises no synchronization issues to be managed by explicit flow-of-control models. Using a simple classical example, the paper shows that it is possible to describe a multilevel model, using SARA, which goes smoothly from programing-in-the-large to programing-in-the-small or actual code. In a second simple case synchronization issues are

vital, and it is important to keep a token machine explicitly in the model. 11 figures.

57820 (UCLA—34P214-40) **State of the implementation of SARA.** Gardner, R.I. (California Univ., Los Angeles (USA). Dept. of Computer Science). 1977. Contract EY-76-S-03-0034-214. 4p. (CONF-770211—7). Computer Society, Long Beach, CA.

From ACM/IEEE symposium on design automation and microprocessors; Palo Alto, California, United States of America (USA) (24 Feb 1977).

The SARA design methodology consists of a structured design procedure together with a set of description and analysis tools. Originally the methodology was used manually. Recently, however, some of the SARA description and analysis tools have been automated and fit into an interactive computer-based design system. The SARA design methodology is made up of two components: a structured procedure for designing digital systems, and a set of tools for modeling and analyzing the systems during their design. The SARA design procedure is not explicitly represented in the set of modeling/analysis tools; that is, there is not an automatic design driver that leads the human designer through a structured design and in turn calls on the appropriate design tools. Rather, the designer interprets the SARA design procedure and selects the use of the appropriate design tools himself. 2 figures.

57821 (UCLA—34P214-42) **Graph model of behavior simulator.** Razouk, R.R.; Estrin, G. (California Univ., Los Angeles (USA). Dept. of Computer Science). 1966. Contract EY-76-S-03-0034-214. 11p. (CONF-770211—3). Computer Society, Long Beach, CA.

From ACM/IEEE symposium on design automation and microprocessors; Palo Alto, California, United States of America (USA) (24 Feb 1977).

An interactive simulator developed at UCLA as part of the SARA system is described. This simulator, in conjunction with other design tools of the SARA system, allows the user to model the behavior of the system being designed at various levels of detail. The models which drive the simulator are control graphs and associated data graphs. The simulator uses the control graph to express synchronization of sequences of events. Initiation of any control node triggers the simulator to call on the data graph model to provide interpretation of a process at a desired level of abstraction. The simulator gives the user the capability to examine, or modify, the state of the control and data graphs during a simulation. 8 figures.

57822 (UCRL—52277) **Implementation of the large mathematical model HEMP on the STAR-100 computers.** Giroux, E.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 May 1977. Contract W-7405-ENG-48. 15p. Dep. NTIS, PC A02/MF 01.

A large, two-dimensional mathematical model was programed for the CDC STAR-100 computer using vector programing techniques. The program is currently running on the two STAR-100 computers and also on the four CDC 7600s at Lawrence Livermore Laboratory. Key implementation methods are discussed with reference to the hardware characteristics that influenced the selection of those methods. Results of a problem are shown along with some running times. 5 figures, 1 table.

57823 (UCRL—79287) **Matching machines and problems.** Wirsching, J.E.; Kishi, T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Mar 1977. Contract W-7405-ENG-48. 21p. (CONF-770413—4). Dep. NTIS, PC A02/MF A01.

From Symposium on high speed computer and algorithm organization; Urbana, Illinois, United States of America (USA) (13 Apr 1977).

Five research projects related to enhancement of computational efficiency are discussed. Problems of parallelism and concurrency are reviewed and conversion of applications to high-speed computers with these characteristics is delineated. Programming methodology is assessed with respect to these applications. The critical issues of parallelism are then exposed and conclusions are drawn. 2 figures, 5 tables.

57824 (UCRL—79308) **Universally faithful transformations for ergodic machines.** Aggarwal, S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Mar 1977. Contract W-7405-ENG-48. 7p. (CONF-770349—1). Dep. NTIS, PC A02/MF A01.

From 11. annual conference on information sciences and systems; Baltimore, Maryland, United States of America (USA) (30 Mar 1977).

The concept of an ergodic machine has been previously introduced in order to study valid simplification of computer simulation models. It was shown that certain conditions must be met for an ergodic machine to model a probabilistic automation aptly—in particular, an ergodic transformation must be faithful. The present paper discusses the idea of a universally faithful transformation—one that "works" for all ergodic machines—and proves that, under very mild conditions, such a transformation does not exist. The question is till open in general. 1 figure.

57825 (UCRL—79316(Rev.1)) **Operator splitting on vector processors.** Dubois, P.F.; Rodrigue, G.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1977. Contract W-7405-ENG-48. 9p. (CONF-770619—4). Dep. NTIS, PC A02/MF A01.

From International symposium on computer methods for partial differential equations; Bethlehem, Pennsylvania, United States of America (USA) (22 Jun 1977).

The basic idea behind operator splitting for two-dimensional time-dependent parabolic partial differential equations is to break the problem down to that of solving two one-dimensional problems. If one uses a vectorized Gauss Elimination to solve these 1-D problems, then one is faced with transposing several matrices in between the two solution processes. Parallel Gauss Elimination is compared with cyclic reduction, which requires no transposes. Actual STAR timings differ markedly from theoretical ones. A compiler allowing users to assign variables to registers eliminates this discrepancy. 2 tables.

57826 (UCRL—79328(Pt.1)) **ELIPTI code: Part I.** Taylor, J.C.; Taylor, J.V. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Mar 1977. Contract W-7405-ENG-48. 32p. (CONF-770619—3). Dep. NTIS, PC A03/MF A01.

From International symposium on computer methods for partial differential equations; Bethlehem, Pennsylvania, United States of America (USA) (22 Jun 1977).

The ELIPTI code is designed to solve arbitrary nonlinear elliptic problems over two-dimensional regions of arbitrary shape. This report deals mainly with the basic structure and content of the code to give a potential user immediate access to its use. The essentials of the algorithm it uses are placed in an appendix. A second report will deal with these matters in more detail. Only sufficient results of its use to exemplify its capabilities are given. 9 figures, 2 tables.

57827 (UCRL—79426) **Software engineering techniques in design automation: a tutorial.** Smith, R.J. II. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Apr 1977. Contract W-7405-ENG-48. 14p. (CONF-770610—1). Dep. NTIS, PC A02/MF A01.

From 14. ACM-IEEE design automation conference; New Orleans, Louisiana, United States of America (USA) (20 Jun 1977).

Several useful software engineering techniques, disciplines, and perspectives are related to typical software development problems in design automation. Specific examples from recent experience illustrate both beneficial and undesirable practices. Oriented toward managers and practicing software engineers, the tutorial discusses system structure, control and data structures, programing guidelines, work habits, testing, documentation, and operational maintenance. 10 figures.

57828 (UCRL—79581) **Using LSI processor bit-slices to build a PDP-11: a case study in microcomputer design.** McWilliams, T.M.; Fuller, S.H.; Sherwood, W.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1977. Contract W-7405-ENG-48. 34p. (CONF-770669—1). Dep. NTIS, PC A03/MF A01.

From National computer conference; Dallas, Texas, USA (13 Jun 1977).

Design and evaluation are given for the CMU-11: a fully operational implementation of the PDP-11 computer architecture built with Intel 3000 Schottky bipolar microcomputer bit-slices. This project was initiated to test in detail the claims that LSI processor bit-slices simplify the design of microprogramed processors. The CMU-11 executes approximately 240,000 instructions per second, which is about 63 percent the speed of the PDP-11/40 and twice the speed of the LSI-11. The additional logic that was added to enable the Intel 3000 circuits to emulate the PDP-11 instruction set is explored in some detail. Full DEC Unibus compatibility was specified, and 29 percent of the integrated circuits used to implement the CMU-11 were required to provide buffering and control of the Unibus. The other main sources of inefficiency were the lack of arithmetic overflow logic in the bit-slices and the organization of the microinstruction control store. Improved LSI circuits in this area can substantially reduce the size (and cost) of the processor. The set of design aids currently available at Carnegie-Mellon University was of critical assistance in this project; a critique of the use of these design aids is included to show their utility in prototype design efforts. 7 figures, 8 tables.

57829 **Convergence of rows of the Pade table.** Baker, G.A. Jr.; Graves-Morris, P.R. (Brookhaven National Lab., Upton, NY). *J. Math. Anal. Appl.;* 57: No. 2, 323-339(Feb 1977).

It is proved that at least an infinite subsequence of [l/2] Pade approximants converge to f(z) if f(z) is holomorphic. It is speculated that convergence of the [L - m/μ + m] approximants to c(z) is associated with convergence of [L/μ] approximants to h(z), where c(z) is meromorphic with μ poles and sigma(z) is the polynomial of degree μ which renders g(z) = sigma(z)c(z) and h(z) = sigma(z)g(z) holomorphic. This conjecture is formulated precisely and proved for

m = 1 and m = 2 and h(z) a holomorphic function of order less than 1.

57830 Computer-aided calculation of insolation of rooms, taking into account different shading factors. Akilov, Yu.Z.; Safaev, A.S.; Turulov, V.A.; Khakimov, K.K. *Geliotekhnika;* No. 1, 82-90(1977). (In Russian).

A method is proposed giving a general picture, the area and isochrones of the duration of insolation. Examples of calculation illustrating the method are presented. Practical realization of the method is possible in civil engineering to calculate thermal loads on air conditioners and to evaluate uv radiation conditions of premises.

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 55697, 55745

57831 (SAND—76-0521) **Barrier Data Base user's guide.** Worrell, R.B.; Gould, D.J.; Wall, D.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1977. Contract EY-76-C-04-0789. 50p. Dep. NTIS, PC A05/MF A01.

A special purpose data base for physical security barriers has been developed. In addition to barriers, the entities accommodated by the Barrier Data Base (BDB) include threats and references. A threat is established as a configuration of people and equipment which has been employed to penetrate (or attempt to penetrate) a barrier. References are used to cite publications pertinent to the barriers and threats in the data base. Utilization and maintenance of the Barrier Data Base is achieved with LIST, QUERY, ENTER, DELETE, and CHANGE commands which are used to manipulate the data base entities.

57832 (UCRL—79286) **Time for atomic and molecular data bases is now (an overview of data management research at LLL).** Hampel, V.E.; Henry, E.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Feb 1977. Contract W-7405-ENG-48. 47p. (CONF-761123—4). Dep. NTIS, PC A03/MF A01.

From Advisory group meeting on atomic and molecular data for fusion; Abingdon, Oxfordshire, United Kingdom of Great Britain and Northern Ireland (UK) (1 Nov 1976).

Two numerical data bases of atomic and molecular (A and M) data required for laser-induced fusion studies were created. One file contains primarily atomic energy levels and atomic transition data released by Charlotte E. Moore in NBS publications. The second file is based on the spectroscopic constants for more than 1000 molecular levels of approximately 160 heteronuclear diatomic molecules prepared by S. N. Suchard. Additional data bases are contemplated in support of the accelerating research activities in these fields. The present paucity of authenticated, computer-readable A and M data is not unlike that observed two decades ago in nuclear fission research. At that time, emphasis was also given to the accurate measurement of physical parameters and to reaction rates which eventually led to the ENDF/B series of evaluated neutron cross sections. Today, powerful computers have a more dominant role in modeling and predicting the results of promising experiments. Their effective use, however, depends more than ever before upon the availability of comprehensive and accurate files of A and M data. At the Lawrence Livermore Laboratory (LLL), these requirements are accentuated by the heavy reliance on computers. Also, trends are presently becoming apparent among users of the national computer network for Magnetic Fusion Energy, with its center at LLL, to coalesce organization-dependent data files into central data bases containing bibliographic information and numerical data as a common resource. The Data Management Research Project is collaborating with the National Bureau of Standards (NBS/NSRDS) to be able to respond to the emerging requirements. This should contribute to a "Public Well" of atomic and molecular data, unencumbered by legal or monetary constraints. 14 figures.

57833 (UCRL—79357) **Comparison of the extended set theory and relational approaches to data base management.** Birss, E.W.; Yeh, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Apr 1977. Contract W-7405-ENG-48. 21p. (CONF-771007—1). Dep. NTIS, PC A02/MF A01.

From 3. international conference on very large data bases; Tokyo, Japan (6 Oct 1977).

Extended set theory has continued to generate interest since it was proposed as a model for data base structures by D. L. Childs in 1968. Some of the concepts he proposed are found in the relational approach to data base management developed by E. F. Codd in 1970. While the relational model has generated a good deal of interest, the extended set theory model has maintained a low profile. To illustrate the extended set model, it is compared with the relational model; the extended set model is found to be more general than the relational model, primarily because of the recursive definition of a set in extended set theory. This definition, and its ramifications, permit some interesting capabilities including data compaction, dynamic restructuring, and physically maintaining multiple updatable views of data. 3 figures, 1 table.

57834 Energy. Washington, D.C.; National Aeronautics and Space Administration (Oct 1976). 272p.

This bibliography lists 602 reports, articles and other documents introduced into the NASA scientific and technical information system from July 1, 1976 through September 30, 1976. The coverage includes regional, national and international energy systems; research and development on fuels and other sources of energy; energy conversion, transport, transmission, distribution and storage, with special emphasis on use of hydrogen and of solar energy. Also included are methods of locating or using new energy resources. Of special interest is energy for heating, lighting, for powering aircraft, surface vehicles, or other machinery. Five indexes--subject, personal author, corporate source, contract number, and report number--are included.

CIVILIAN DEFENSE

57835 (CPG—1-5A) **Local program paper handbook.** (Defense Civil Preparedness Agency, Washington, D.C. (USA)). Jan 1977. 46p. Civil Preparedness Agency, Washington, DC.

This publication supersedes CPG 1-5A, Program Evaluation Handbook, January 1976. It is a guide for evaluation of local emergency operational civil defense capability and for programming to improve that capability, and should be used in conjunction with CPG 1-5, Standards for Local Civil Preparedness, and CPG 1-3, Federal Assistance Handbook.

CORPORATE INDEX

In the corporate index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

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A

Abcor, Inc., Cambridge, Mass. (USA). Walden Research Div.
Technical support to the state of Connecticut in development of an air quality maintenance plan. Final report, 2:57356 (PB—264362)
Action Associates, Inc., Bridgeport, Conn. (USA)
Job creation through energy conservation: a solution to a crisis, 2:56918 (PB—265295)
Aerojet Nuclear Co., Idaho Falls, Idaho (USA)
LOFT experiment operating specification. LOFT nonnuclear experiment series L-1. EOS Volume 1. Appendix A. Revision 2. Change No. L1-A-1, 2:56757 (TID—27663)
Agbabian Associates, El Segundo, Calif. (USA)
Determination of equivalent response cycles for use in earthquake-induced fatigue analyses, 2:56793 (SAN/1011—106)
Equivalent viscous damping for seismic analyses of nuclear plants, 2:56792 (SAN/1011—103)
Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs - Operations Office
Alternative fuel cycle technology progress report for April 1—June 30, 1977, 2:55900 (ICP—1122)
Allis-Chalmers Corp., Milwaukee, Wis. (USA)
Current limiting fuse study. Final report, 2:56349 (EPRI-EL—453(6-77))
American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc., New York
Proceedings of the international conference on liquid metal technology in energy production, 2:56477 (CONF-760503—P1)
Proceedings of the international conference on liquid metal technology in energy production, 2:56529 (CONF-760503—P2)
American Nuclear Society, Hinsdale, Ill.
Proceedings of the international conference on liquid metal technology in energy production, 2:56477 (CONF-760503—P1)
Proceedings of the international conference on liquid metal technology in energy production, 2:56529 (CONF-760503—P2)
American Nuclear Society, Pittsburgh, Pa. Pittsburgh Section
Proceedings of the international conference on liquid metal technology in energy production, 2:56477 (CONF-760503—P1)
Proceedings of the international conference on liquid metal technology in energy production, 2:56529 (CONF-760503—P2)
Ames Lab., Iowa (USA)
Environmental monitoring at Ames Laboratory: calendar year 1976, 2:56756 (IS—4139)
Floatability of coal and pyrite, 2:55553 (IS-T—779)
Users guide to finger, thumb, and triple axis real time experiment control programs, 2:57335 (IS—4169)
AN SSSR, Moscow. Inst. Prikladnoj Matematiki
Compton-radiation gas dynamics, 2:57620 (UCRL-Trans—11236)
Argonne National Lab., Ill. (USA)
Argonne Bioanalytical Center: a resource for collaborative biomedical applications of stable isotopes, 2:57407 (CONF-761234—3)
Comments on the energy-averaged total neutron cross sections of structural materials in the few MeV range, 2:57591 (ANL/NDM—33)
Davidon's optimally conditioned algorithms for unconstrained optimization, 2:57807 (ANL-AMD-TM—283(Rev.))
Detection of a partial blockage in a heterogeneous core, 2:56476 (ANL-CT—77-30)
Equations of state for alkali metals near their critical points, 2:57128 (CONF-770537—4)
Final report on Test L4, a loss-of-flow experiment, 2:56766 (ANL—76-130)
High temperature coal and slurry combustor according to a one-dimensional flow model, 2:55722 (CONF-770530—2)
HYCSOS: a chemical heat pump and energy system based on metal hydrides, 2:57002 (ANL—77-39)
Postirradiation examinations of the BG-9 element, 2:56475 (ANL—8067)
Relationship between the BFGS and conjugate gradient algorithms, 2:57806 (ANL-AMD-TM—282(Rev.))
Some subroutines for producing captioned contour line plots and line graphs on film, 2:57805 (ANL-AMD-TM—191)
Theoretical studies of the atmospheric triatomic molecules H_2O, N_2O, NO_2, CO_2, O_3, and their ions, 2:57501 (ANL—77-3)
Thermodynamic functions and vapor pressures of uranium and plutonium oxides at high temperatures, 2:55867 (CONF-770537—2)
Versatile multiple outlet semi-ball and socket valve, 2:57250 (CONF-770634—1)
Arkansas Univ., Fayetteville (USA). Dept. of Civil Engineering
Permeability of fly ash and fly ash stabilized soils. Final report on highway research project no. 47, 2:55648 (PB—265229)
Army Test and Evaluation Command, Aberdeen Proving Ground, Md. (USA)
Endurance testing of tracked and wheeled vehicles. Final report, 2:57072 (AD-A—037827)
Atlantic Richfield Hanford Co., Richland, Wash. (USA)
Calculated and observed nonisothermal multiphase in flow in vertical columns, 2:57375 (ARH-SA—278)
Determination of aluminum by four analytical methods, 2:57199 (ARH-ST—131)
Hanford groundwater scenario studies, 2:57397 (ARH-SA—292)
Purex process operation and performance, 1970 Thoria Campaign, 2:55879 (ARH—2127)
Australian Atomic Energy Commission Research Establishment, Lucas Heights
Ranger uranium environmental enquiry. Final submission by the Australian Atomic Energy Commission, 2:55934 (INIS-mf—3272)
Automation Industries, Inc., Silver Spring, Md. (USA). Vitro Labs. Div.
Fiscal year 1976/health and environmental effects research program abstracts, 2:57360 (PB—265381)

B

Babcock and Wilcox Co., Lynchburg, Va. (USA)
Studies of a small PWR for onsite industrial power, 2:56608 (CONF-770403—15)

Baltimore Gas and Electric Co., Md. (USA)
Perryman Nuclear Power Plant. Site suitability--site safety report, volume I: chapters-sections 1.1, 1.2, 1.4, 1.6; 2.1, 2.2, 2:56581 (DOCKET-50586—1)

Battelle Columbus Labs., Ohio (USA)
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Bibliography on available computer programs in the general area of heating, refrigerating, air conditioning and ventilating. Research project, 2:57004 (PB—264904)
CDIF combustor Instrumented Test Section. Final report, 2:56988 (TID—27147)
Evaluation of selected chemical processes for production of low-cost silicon (Phase II). Silicon Material Task, Low-Cost Silicon Solar Array Project. Fifth—sixth quarterly progress report, October 1, 1976—March 31, 1977, 2:56033 (ERDA/JPL/954339—77/1)
Heat source component development program. Quarterly report for April—June 1977, 2:55973 (BMI-X—683)
Proposed outline for a safety analysis report for a radioactive waste repository, 2:55917 (Y/OWI/SUB—76/7253/1)
Steam—water mixing and system hydrodynamics program. Task 4. Quarterly progress report, October—December 1976, 2:56767 (BMI-NUREG—1968)
Study of heat transfer through refractory lined gasifier vessel walls. Quarterly progress report, December 1976—February 1977, 2:55573 (FE—2210-12)
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Battelle Pacific Northwest Labs., Richland, Wash. (USA)
Analysis of electricity production costs from the geopressured geothermal resource, 2:56194 (BNWL—2192)
Feasibility of monitoring the strength of HTGR core support graphite: Part I, 2:56427 (BNWL—2239)
Finite element models for sediment and contaminant transport in surface waters. Transport of sediments and radionuclides in the Clinch River, 2:57398 (BNWL—2227)
Hanford reservation area worker census: a research report for the Rockwell Hanford Operations, 2:56916 (BNWL—2298)
Homogeneous catalytic hydrogenations of complex carbonaceous substrates, 2:55555 (BNWL-SA—6055)
Land rehabilitation research at Pacific Northwest Laboratories, 2:57387 (BNWL-SA—6089)
Overview of economic, legal, and water availability factors affecting the demand for dry and wet/dry cooling for thermal power plants, 2:56237 (BNWL—2268)
Plutonium in human lung in the Hanford environs, 2:57436 (BNWL-SA—5855)
Ratio estimation techniques in the analysis of environmental radionuclide data, 2:57379 (BNWL-SA—5975(Rev.))
Study of the comparative costs of five wet/dry cooling tower concepts, 2:56236 (BNWL—2122)

Bechtel Corp., San Francisco, Calif. (USA)
Coal mine-coal conversion plant interface evaluation and conceptual design. Phase II. Monthly technical progress report, 1 April—30 April 1977, 2:55582 (FE—2370-13)
Laser fusion hybrid reactor systems study, 2:57769 (UCRL—13720)

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Fabricate and evaluate protective canopies for 3-foot coal seams. Final report, 1975—1976, 2:55673 (PB—265073)

Bendix Corp., Kansas City, Mo. (USA)
Monitoring sinusoidal vibration environments with a television system, 2:57314 (BDX—613-1295(Rev.))

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Brookhaven National Lab., Upton, N.Y. (USA)
Cryopumping of deuterium hydrogen and helium mixtures on smooth 4.2 K surfaces, 2:57785 (BNL—22759)
Data report: Marsh/Pond system, 2:57390 (BNL—50600)
ENDF/B fission product decay data, 2:57588 (BNL-NCS—50545(Vol.1))
ENDF/B fission product decay data, 2:57589 (BNL-NCS—50545(Vol.2))
Individual air pollution monitors. 2. Examination of some nonoccupational research and regulatory uses and needs, 2:57352 (BNL—50637)
Influence of tensile stresses on the superconducting temperature of multifilamentary Nb_3Sn composite conductors, 2:57107 (BNL—23016)
Land use—energy simulation model: a computer-based model for exploring land use and energy relationships, 2:56915 (BNL—50634)
Mechanism for the degradation of superconducting transition temperatures on high energy neutron radiation in A-15 compounds, 2:57125 (BNL—23053)
Neutron diffraction studies of tetrahedral cluster transition metal hydride complexes: $HFeCO_3(CO)_9(P(OCH_3)_3)_2$ and $H_3Ni_4(C_5H_5)_4$, 2:57209 (BNL—22982)
Overview of technological-economic models for energy policy analysis, 2:56954 (BNL—22730)
Regional reference energy systems, 2:56948 (EPRI-EA—462)
Synthetic carbonaceous fuels and feedstocks from oxides of carbon and nuclear power, 2:55981 (BNL—22785)
Thermoluminescence, a method for determining the date at which a ceramic object was fired, 2:57200 (BNL—22811)
^{122}Xe—^{122}I generator: a preliminary report, 2:57243 (BNL—22993)

Brown Univ., Providence, R.I. (USA)
Flame suppression on cylindrical fuel rods, 2:57248

Brown Univ., Providence, R.I. (USA). Div. of Engineering
Segregation induced embrittlement of grain interfaces, 2:57111 (COO—3084-52)

Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Strahlenhygiene
Status report on environmental radioactivity monitoring in the Federal Republic of Germany, 2:57367 (STH—6/76)

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Investigation of acid-resistant electrocatalysts for fuel cells, 2:56999 (N—77—16444)

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Report on the Western Energy Expansion Study, 2:56986 (NP—22295)

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California Inst. of Tech., Pasadena (USA). W.M. Keck Lab. of Engineering Materials
Ferromagnetic and antiferromagnetic coupling in amorphous (Ni/sub 100-c/Mn/sub c/)$_{75}P_{14}B_6$, 2:57127 (CALT—822-91)

Magnetic regimes in amorphous Ni—Fe—P—B alloys, 2:57126 (CALT—822-88)
NMR and Moessbauer studies of the amorphous system $Fe_{79}P$/sub 21-x/B/sub x/, 2:57101 (CALT—822-95)
California Univ., Berkeley (USA)
Dew points of hot gases from coal gasification processes. Quarterly report, June 1—August 31, 1976, 2:55571 (FE—2046-1)
Dew points of hot gases from coal gasification processes. Quarterly report, September 1—November 30, 1976, 2:55572 (FE—2046-2)
California Univ., Berkeley (USA). Lawrence Berkeley Lab.
Atmospheric aerosol research. Annual report, 1975—1976, 2:57355 (LBL—5214)
Effect of silicon on the environmental cracking behavior of a high strength steel, 2:57114 (LBL—6012)
Kinetics of formation of the A-15 phase in the Nb—Al—Ge system, 2:57105 (LBL—6266)
Nitinol self-descaling surface for geothermal scale control, 2:56201 (LBL—6324)
Standards for multilateral and world wide exchange of geothermal data, 2:56169 (LBL—6305)
Studies of design parameters in the fabrication of Nb—Al—Ge superconductors by the powder metallurgy infiltration method, 2:57091 (LBL—5772)
Study of nuclear material accounting. Final report, July 1, 1976—April 1, 1977, 2:55956 (NUREG—0290(Vol.1))
Study of nuclear material accounting. Final report, July 1, 1976—April 1, 1977, 2:55958 (NUREG—0290(Vol.3))
Study of nuclear material accounting. Final report, July 1, 1976—April 1, 1977, 2:55957 (NUREG—0290(Vol.2))
Surface crystallography of clean platinum single crystals and adsorbed hydrocarbon overlayers studied by low energy electron diffraction, 2:57211 (LBL—6221)
California Univ., Berkeley (USA). Operations Research Center
Estimates and sampling schemes for the instrumentation of accountability systems, 2:55902 (UCRL—13733-1)
California Univ., Davis (USA). Dept. of Applied Science
Trapped particles and harmonic generation, 2:57675 (UCRL—13727)
California Univ., Davis (USA). Dept. of Mechanical Engineering
Titanium—oxygen system: review of structure, thermodynamics, and phase equilibria, 2:57154 (UCRL—13726)
California Univ., Livermore (USA). Lawrence Livermore Lab.
Characterizing cinder rock with the scanning electron microscope, 2:55834 (UCID—17492)
Comparing structural loads in large pools evaluated with the LUSH code and current design methods, 2:56796 (UCRL—79277)
Comparison of the extended set theory and relational approaches to data base management, 2:57833 (UCRL—79357)
Determination of performance criteria for high-level solidified nuclear waste, 2:55896 (NUREG—0279)
Dose assessment at Bikini Atoll, 2:57437 (UCRL—51879(Pt.5))
Dynamics of oil generation and degradation during retorting of oil shale blocks and powders, 2:55836 (UCRL—79034)
ELIPTI code: Part I, 2:57826 (UCRL—79328(Pt.1))
Empirical relation for dilatant behavior in brittle rocks, 2:57474 (UCRL—79011)
Equations of state for detonation products of high energy PBX explosives, 2:57348 (UCID—17540)
Evaluation of the hazard associated with fabricating beryllium copper alloys, 2:57461 (UCRL—52258)
Explosive testing at the Lawrence Livermore Laboratory: philosophy and practice, 2:57349 (UCRL—79391)
Fiber-composite flywheel program. Quarterly progress report, January—March 1977, 2:56886 (UCRL—50033-77-1)
FORMS: a generator of time-card forms, 2:57817 (UCID—30151)
Geometrical theory of nonlinear phase distortion of intense laser beams, 2:57286 (UCRL—76834)
Ground subsidence resulting from underground gasification of coal, 2:55584 (UCRL—5225)
High pressure apparatus for hydrogen isotopes to pressures of 345 MPa (50,000 psi) and temperatures of 1200°C, 2:57253 (UCRL—78886)
Hydrogeochemical and stream-sediment survey of the National Uranium Resource Evaluation (NURE) program: western United States. Quarterly progress report, January—March 1977, 2:55856 (UCID—16911-77-1)
Implementation of the large mathematical model HEMP on the STAR-100 computers, 2:57822 (UCRL—52277)
Laboratory experiment demonstrating the way in which a steam barrier prevents the dissolution of salt buried in a flooded packed bed, 2:57212 (UCID—17507)
Laser fusion implosion and target interaction physics, 2:57771 (UCRL—79540)
Lifetimes of fiber composites under sustained tensile loading, 2:57252 (UCRL—78367)
Magnetic fusion energy, 2:57691 (UCRL—79600)
MANAGER: a generator of reports on the expenditure of scientific manpower, 2:57818 (UCID—30152)
Matching machines and problems, 2:57823 (UCRL—79287)
Material control assessment procedure, 2:57384 (UCRL—79214(Rev.1))
Material control assessment procedure, 2:55966 (UCRL—79214)
Metallic high pressure equation-of-state derived from experimental data, 2:57106 (UCRL—79032)
Methane formation in tritium gas exposed to stainless steel, 2:55968 (UCRL—52262)
Modified in-situ oil shale technology at the Lawrence Livermore Laboratory: experimental results and present status, 2:55837 (UCRL—79149)
MOS solid-state detector arrays for x-ray imaging, 2:57336 (UCRL—79376)
Oil shale retorting. Part I. The effects of particle size and heating rate on oil evolution and intraparticle oil degradation, 2:55835 (UCRL—52256(Pt.1))
Operator splitting on vector processors, 2:57825 (UCRL—79316(Rev.1))
Operators guide: Atmospheric Release Advisory Capability (ARAC) site facility, 2:57368 (UCID—17490)
Proposed safety standards for ERDA trailers and other portable structures, 2:57313 (UCID—17456)
Reactor containment analysis for BWR suppression systems. Progress report for January—March 1977, 2:56795 (UCRL—50045-77-1)
Response of porous beryllium to static and dynamic loading, 2:57118 (UCRL—79712)
Review of the mirror hybrid reactor, 2:57690 (UCRL—79548)
Silica vaporization and condensation: a potential source of fouling in coal combustion, 2:55650 (UCRL—79146)
Software engineering techniques in design automation: a tutorial, 2:57827 (UCRL—79426)
Theoretical interpretation of angle- and polarization-dependent laser light absorption measurements, 2:57772 (UCRL—79628)
Theoretical studies of soliton-like behavior of shocks in one-dimensional systems, 2:57623 (UCRL—79259)
Time for atomic and molecular data bases is now (an overview of data management research at LLL), 2:57832 (UCRL—79286)
Universally faithful transformations for ergodic machines, 2:57824 (UCRL—79308)
User's guide to the LLL BASIC interpreter, 2:57816 (UCID—17090(Rev.1))
Using LSI processor bit-slices to build a PDP-11: a case study in microcomputer design, 2:57828 (UCRL—79581)
Wave-breaking amplitudes in warm, inhomogeneous plasmas, 2:57676 (UCRL—79604)
California Univ., Los Angeles (USA)
Simplified method of computing clad and fuel strain and stress during irradiation, 2:56560
California Univ., Los Angeles (USA). Dept. of Computer Science
Graph model of behavior simulator, 2:57821 (UCLA—34P214-42)
Specialization of SARA for software synthesis, 2:57819 (UCLA—34P214-37)
State of the implementation of SARA, 2:57820 (UCLA—34P214-40)
California Univ., Los Angeles (USA). Dept. of Electrical Sciences and Engineering
Experimental simulation of parametric instabilities in laser-plasma interactions. Interim report, 2:57766 (AD-A—037761)
California Univ., Los Angeles (USA). Dept. of Energy and Kinetics
Decision-table development for use with the CAT code for the automated fault-tree construction, 2:56790 (PB—265098)
On the probability of loss of dc power following ac failure in a nuclear power plant, 2:56791 (PB—265099)
Risks from the storage of hazardous chemicals, 2:57458 (PB—265115)
Some probabilistic aspects of the seismic risk of nuclear reactors, 2:56789 (PB—265020)

California Univ., Los Angeles (USA). Inst. of Geophysics and Planetary Physics
Predicted transport of air pollutants from the Navajo and Kaiparowits generating stations into Lake Powell, 2:57359 (PB—265101)
California Univ., Santa Barbara (USA). Marine Science Inst.
Oil spill and oil pollution reports, May 1976—July 1976. Quarterly report, 2:55792 (PB—264870)
Calspan Corp., Buffalo, N.Y. (USA)
Research safety vehicle program (Phase II) specification review. Volume II. Final technical report, Jul 1975—Nov 1976, 2:57073 (PB—264516)
Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Dept. of Chemical Engineering
Synthoil hydrodynamics. Final report, 2:55600 (COO—0056-4)
Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Dept. of Physics
Heat transfer problems in an ocean thermal power plant, 2:56090 (COO—4041-2)
Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Transportation Research Inst.
Technical feasibility study of railroad electrification with high voltage (10-50 kV) direct current. Final report, Jan—Jun 1976, 2:57065 (PB—265018)
Catalytic, Inc., Wilsonville, Ala. (USA)
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CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)
Experimental studies on sodium fires application to reactors, 2:56580 (NP-tr—1980)
Center for Natural Areas, Washington, D.C. (USA)
Environmental planning and the siting of nuclear facilities: the integration of water, air, coastal, and comprehensive planning into the nuclear siting process. Improving regulatory effectiveness in federal/state siting actions, 2:56582 (NUREG—0199)
Charles F. Kettering Foundation, Dayton, Ohio (USA)
Predicted transport of air pollutants from the Navajo and Kaiparowits generating stations into Lake Powell, 2:57359 (PB—265101)
Chicago Univ., Ill. (USA)
Biokinetics of Tl-201 in mice after intravenous and oral administration of TlCl, 2:57439 (CONF-770673—1)
Cincinnati Univ., Ohio (USA)
Radiation cleanup of vacuum systems (radiation-induced outgassing). Progress report, September 15, 1976—September 14, 1977, 2:57787 (COO—4093-1)
Clinch River Breeder Reactor Plant Project Office, Oak Ridge, Tenn. (USA)
Clinch River Breeder Reactor Plant technical review, 2:56534 (CRBRP-PMC—77-03)
Use of reliability in the LMFBR industry, 2:56771 (CONF-770625—3)
Cold Regions Research and Engineering Lab., Hanover, N.H. (USA)
Detecting structural heat losses with mobile infrared thermography. Part III. Survey of USA CRREL, 2:57003 (NP—22267)
Colorado State Univ., Fort Collins (USA). Dept. of Atmospheric Science
Comparison of a thermopile broadband detector and a photon detector for the measurement of solar radiation. Part I. Analysis of simultaneous data. Part II. Cosine response functions, 2:56022 (PB—265282)
Colorado State Univ., Fort Collins (USA). Dept. of Electrical Engineering
Polarized particle levitation in hexapole field, 2:57770 (UCRL—13735-2)
Colorado State Univ., Fort Collins (USA). Dept. of Physics
Industrial ion source technology. Annual report, 2:57493 (N—77—16248)
Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.
Toxicological evaluation of liquids proposed for use in direct contact liquid—liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867—1)
Columbia Gas Transmission Corp., Charleston, W.Va. (USA)
Tertiary oil recovery by CO_2 injection. Quarterly report, October—December 1976, 2:55755 (FE—5302-5)
Columbia Univ., New York (USA)
The development of visible molecular lasers. Final report, 2:57282 (AD-A—037488)
Combustion Engineering, Inc., Windsor, Conn. (USA)
C-E burnable poison irradiation test program. (CEN No. 50), 2:56721 (NP—22113)
Instrumentation qualification. Seismic qualification of C-E instrumentation equipment. Part One, 2:56769 (CENPD—182(Pt.1))
Instrumentation qualification. Seismic qualification of C-E instrumentation equipment. Part Two, 2:56770 (CENPD—182(Pt.2))
Compagnia Generale di Elettricita S.p.A., Milan (Italy). Div. Elettronica
Testing of NiCd cells over geostationary orbit type cycling period, 2:56898 (N—77-10661)
Compagnie d'Ingenierie pour les Reacteurs au Sodium (CIRNA), Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)
Experimental studies on sodium fires application to reactors, 2:56580 (NP-tr—1980)
Consolidated Controls Corp., El Segundo, Calif. (USA)
Coal gasification valves. Phase I. Component development test procedure, 2:55575 (FE—2355-12(Rev.A))
Coal gasification valves. Phase I. Design analysis report, 2:55578 (FE—2355-15)
Coal gasification valves. Phase I. Stress analysis report, 2:55576 (FE—2355-13)
Coal gasification valves. Phase I. Thermal analysis report, 2:55579 (FE—2355-16)
Coal gasification valves. Phase I. Thermal analysis report, 8-inch, Types I, II, and IV valves, 2:55580 (FE—2355-19)
Coal gasification valves. Phase I. Type III valve prototype test plan, 2:55577 (FE—2355-14)
Consultex, S.A., Geneva (Switzerland)
European waste-to-energy systems. Case study of Munich: Munich North IA and IB, Munich North II, Munich South IV and V, 2:56981 (CONS/2103—4)
European waste-to-energy systems: case study of Geneva-Cheneviers (Switzerland), 2:56987 (CONS/2103—2)
Continental Illinois National Bank and Trust Co., Chicago (USA)
Capital for coal development, 2:55730 (CONF-7511130—1)
Cornell Univ., Ithaca, N.Y. (USA)
Mechanical behavior of materials and structural elements at elevated temperatures. Progress report, June 1, 1976—May 31, 1977, 2:57110 (COO—2733-11)
Transmission electron spin resonance in dilute CuFe alloys, 2:57103 (COO—3150-39)
Cornell Univ., Ithaca, N.Y. (USA). Dept. of Materials Science and Engineering
Influence of grain boundaries on the electrical transport properties of polycrystalline Si films. Progress report, 2:57174 (COO—2899-1)
Cornell Univ., Ithaca, N.Y. (USA). Dept. of Theoretical and Applied Mechanics
Lateral buckling and vibrations of superconducting magnets for magnetic fusion reactors. Progress report, October 1976—May 1977, 2:57731 (COO—2780-3)
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D

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Local program paper handbook, 2:57835 (CPG—1-5A)
Delaware Univ., Newark (USA). Inst. of Energy Conversion
Advances in the development of efficient thin film CdS/Cu_2S solar cells, 2:56044 (TID—27697)
Studies related to Zn/sub x/Cd/sub 1-x/S solar cells. Technical report IEC/PV/TR/76/4, 2:56028 (CONF-761130—4)
Department of Environment, Housing and Community Development, Canberra (Australia)
Solar water heating in dwellings. survey of selected prospective users in sydney, 2:56112 (PB—264151)
Department of the Air Force, Washington, D.C. (USA)
Coal catalyst, 2:55629 (AD-D—003508)
Fusible heat sink for a cryogenic refrigerator, 2:57265 (AD-D—003515)

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Semiscale Mod-1 system response during the ECC baseline test series (design of the Mod-1 baseline ECC test), 2:56408 (TREE-NUREG—1058)
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In situ oil shale fracturing experiment: some preliminary results, 2:55831 (SAND—77-0422C)
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Problems solved and problems not solved in UCG, 2:55560 (CONF-770510—6)
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Oxygen concentration distribution in β-phase of the Zry-4 cladding during Zr-steam reaction at LOCA, 2:56781 (JAERI-M—6538)
Purification process studies for the reprocessing by fluoride volatility method, 2:55882 (JAERI-M—6592)
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Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57198 (LA—6869-MS)
Bayesian Zero-Failure (BAZE) reliability demonstration testing procedure for components of nuclear reactor safety systems, 2:56784 (LA—6813-MS)
Chemical vapor deposition of tantalum on graphite cloth for making hot pressed fiber reinforced carbide-graphite composite, 2:57164 (LA-UR—77-1261)
Coulometer operator's manual, 2:57194 (LA—6883-MS)
Determination of the Grueneisen γ for beryllium at 1.2 to 1.9 times standard density, 2:57113 (LA-UR—77-1292)
Empirical model to compute the velocity histories of flyers driven by electrically exploding foils, 2:57249 (LA—6809)
Energy flow patterns for 1975, 2:56982 (LA—6770)
Evaluation of the LASL automated spectrophotometer for uranium determination at submilligram levels, 2:57203 (LA—6867)
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Feedback stabilization experiments using $l = 2$ equilibrium windings in Scyllac, 2:57661 (LA-UR—77-1142)
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Fundamental statistical methods in particle science, 2:57181 (LA-UR—77-1098)
Geology and hydrology in the vicinity of the inactive uranium mill tailings pile, Ambrosia Lake, New Mexico, 2:55935 (LA—6839-MS)
Influence of metals on the thermal decomposition of s-triaminotrinitrobenzene (TATB), 2:57345 (LA—6873-MS)
INGEN: a general purpose mesh generator for finite element codes, 2:57812 (LA-UR—77-1345)
K-FIX: a computer program for transient, two-dimensional, two-fluid flow, 2:56785 (LA-NUREG—6623)
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Mathematical analysis of DNA histograms from asynchronous and synchronous cell populations, 2:57417 (LA-UR—77-992)
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Safeguards system design methodology, 2:55961 (SAND—77-0890C)
Sandia's solar total energy program, 2:56099 (SAND—75-5880)
Shock and vibration environments for large shipping containers on rail cars and trucks, 2:57278 (SAND—76-0427)
Some applications of high pressure studies of phase transitions in solids, 2:57175 (SAND—77-0104C)
Stress waves measured and calculated for in situ explosive rubblization experiments in oil shale, 2:55832 (SAND—77-0779C)
Surveillance and containment instrumentation international safeguards, 2:55962 (SAND—77-0980C)
Tower design considerations for the solar thermal central receiver systems, 2:56086 (SAND—77-8243)
Ultrasonic data acquisition, analysis, and display by minicomputer aided techniques, 2:57308 (SAND—77-0526C)
Use of $^{12}C(d,p)^{13}C$ and $^{16}O(d,p)^{17}O$ reactions, 2:57189 (SAND—77-0366C)
Waste Isolation Pilot Plant (WIPP) conceptual design report. Part I: executive summary. Part II: facilities and system, 2:55915 (SAND—77-0274)

Wind tunnel performance data for two- and three-bucket Savonius rotors, 2:56222 (SAND—76-0131)

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Evaluation of safeguards systems for nuclear material in transit: the development of the program plan. Winter 1977 quarterly report, 2:55964 (SAND—77-8249)

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Proceedings of a workshop on the measure of intangible environmental impacts, 2:57403 (EPRI-EA—405-SR)
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Web-dendritic ribbon growth. Quarterly report, January 1, 1977—March 31, 1977, 2:56035 (ERDA/JPL/954344—77/1)

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Novel duplex vapor-electrochemical method for silicon solar cells. Quarterly progress report No. 4, November 1, 1976—January 31, 1977, 2:56039 (ERDA/JPL/954471—77/1)
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Impulsive solar x-ray bursts. 3. Polarization and directivity of bremsstrahlung radiation from a beam of electrons directed toward the photosphere, 2:57482 (N—77-16976)
Impulsive solar x-ray bursts. 4: polarization, directivity and spectrum of the reflected and total bremsstrahlung radiation from a beam of electrons directed toward the photosphere, 2:57483 (N—77—16977)

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Silicon photovoltaic cells in thermophotovoltaic conversion. Progress report, 2:56030 (EPRI-ER—478)

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Environmental impact analysis of Coyote Station. Volume 1, 2:56344 (NP—22244(Vol.1))
Environmental impact analysis of Coyote Station. Volume 2, 2:56357 (NP—22244(Vol.2))

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BOBL code. Experimental verification of the hydraulic model, including effects of pin bowing and grids, 2:56536 (ECN—9)
Fast reactor programme; irradiation effects on the mechanical properties of 18Cr-11Ni stainless steel (DIN 1.4948, type AISI 304 ss). First status report, 2:57142 (ECN—4)

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Flow of radioactive gases through ground layers, 2:56750 (IKE—6-104)

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The chemistry, dispersion, and transport of air pollutants emitted from fossil fuel power plants in California: data analysis and emission impact model. Final report, 2:57357 (PB—264822)

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Investigation of coupling of field emission cold cathode guns for gas lasers. Final technical report, 2:57283 (AD-A—037734)

T

Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Bergbau und Huettenwesen
Agglomerated brown coal fine coke as a sintering fuel, 2:55644 (NP—22126)

Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl fuer Raumfahrttechnik
Energy storage during orbital and interplanetary missions, 2:56883 (AED-CONF—76-377-002)

Tennessee Univ., Knoxville (USA). Dept. of Electrical Engineering
Study of low-frequency excess noise in hybrid thick-film resistors, 2:57315 (ORNL/Sub—3961/2)

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ν bodies are close-packed in chromatin fibers, 2:57412 (CONF-770648—2)
Conformational states of chromatin, 2:57411 (CONF-770648—1)

Tennessee Univ., Oak Ridge (USA). School of Biomedical Sciences
DNA replication of the parvovirus Kilham rat virus. I. Characterization of intracellular forms of viral DNA extracted by guanidine hydrochloride, 2:57410 (CONF-770555—2)

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Characterization of ash from coal-fired power plants. Milestone report May 75-Mar 76, 2:55649 (PB—265374)

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Toxicology Information Response Center literature search index, June 1976—May 1977. III. 2601—3100, 2:57445 (ORNL/TIRC—77/6)

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Action Plan for improving power plant productivity, 2:56594 (PB—264565)
Power plant productivity: an assessment of outages at two coal-fired and two nuclear plants, 2:56593 (PB—264564)

U

UKAEA Reactor Group, Dounreay. Dounreay Experimental Reactor Establishment
Operation of PFR and influence upon the design of CFR I, 2:56541 (TRG-Report—2819(D))

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Actinide fission rate measurements in Zebra, 2:56474 (AEEW-R—1090)

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Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R—1746)

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Conceptual design criteria for facilities for geologic disposal of radioactive wastes in salt formations, 2:55920 (Y/OWI/TM—9)

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Summary of geologic review group meeting, January 20—21, 1977, 2:55919 (Y/OWI/TM—8/1)

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Preliminary feasibility evalution of compressed air storage power systems. Volume II. Appendices, period June 1975—December 1976, 2:56884 (CONS/NSF/42—1)

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Characterization of coal liquids. Intermediate report for the period July—December 1975. Upgrading solvent refined coal process filter feed, 2:55624 (FE—2010-01)

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Study to determine research and development needs in western mining. Final report, 2:57281 (PB—264429)

V

Varta Batterie A.G., Kelkheim (Germany, F.R.). Forschungs- und Entwicklungszentrum
Electrochemical power sources in ocean engineering, 2:56897 (AED-CONF—76-203-006)
Virginia Dept. of Highways and Transportation, Richmond (USA)
Organizing and operating a vanpool program: feasibility of vanpooling in Virginia. Final report, 2:56940 (PB—264635)
Virginia Energy Resource Advisory Commission, Richmond (USA)
Energy and Virginia's future: a report of the Virginia Energy Resource Advisory Commission, 2:56949 (NP—21880)
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Organizing and operating a vanpool program: feasibility of vanpooling in Virginia. Final report, 2:56940 (PB—264635)
Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)
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Virginia Univ., Charlottesville (USA). Dept. of Civil Engineering
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W

Washington Univ., Seattle (USA)
Gamma heated subassembly for sodium boiling experiments, 2:56794 (TID—27639)
Western Michigan Univ., Kalamazoo (USA). Dept. of Chemistry
Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, 11 September—10 December 1976, 2:55723 (FE—2018-6)
Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, December 11, 1976—March 10, 1977, 2:55724 (FE—2018-7)
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Characterization and aging kinetics study of gamma prime strengthened Fe—Cr—Ni experimental alloys for breeder reactors, 2:57119 (WARD-AD—3045-5)
Clinch River Breeder Reactor Plant. Flow induced vibration of fuel rods in CRBRP, 2:56533 (CRBRP-ARD—0166)
Clinch River Breeder Reactor Plant. Irradiated EBR-II duct crushing test and analysis, 2:56755 (CRBRP-ARD—0164)
Optimized method for orificing LMFBR cores, 2:56530 (CONF-770611—6)
Westinghouse Electric Corp., Pittsburgh, Pa. (USA)
Operational experience with Westinghouse cores (up to December 31, 1976), 2:56409 (WCAP—8183(Rev.6))
Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.
Fusion-driven actinide burner design study. Final report, 2:57755 (EPRI-ER—451(Vol.1)(5-77))
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Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Research and Development Center
Silicon Materials Task of the Low Cost Solar Array Project (Phase II). Sixth quarterly report, 1 January 1977—March 31, 1977, 2:56032 (ERDA/JPL/954331—77/2)
Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering
Systematic approach to the radiation damage problem in fission and fusion reactor structural alloys, 2:57143 (UWFDM—184)
Wisconsin Univ., Madison (USA). Inst. for Environmental Studies
Oil shale development in northwestern Colorado: water and related land impacts. Water resources management workshop, 2:55851 (IES—48)
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Mesoscale air pollution transport in southeast Wisconsin. Final report 1972-1976, 2:57361 (PB—265382)
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Y

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Fate of nuclides in natural water systems. Annual progress report, October 1, 1976—September 30, 1977, 2:57353 (COO—3573-26)

Z

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Technology index for plasmaphysics research and fusion reactors. Volume 11, No. 6, 1977. Bibliography, author index, subject index, appendix, 2:57626
Technology index for plasmaphysics research and fusion reactors. Volume 11, No. 5, 1977. Bibliography, author index, subject index, appendix, 2:57627

AUTHOR INDEX

Authors' surnames are indexed in the form appearing in the abstracted publication; given names are reduced to initials. Each author entry gives the publication title and the citation number. Report numbers, if applicable, are given in parentheses at the end of the entry. For publications with multiple authors, an author entry is provided for each. Entries for the second and succeeding author give a reference to first author.

Because of problems involved in the mechanical preparation of this index, all accent marks are omitted. Changes in spelling introduced as a result of accent omission follow standard conventions.

A

Aamodt, B., Application of a general purpose finite element program system in pressure vessel technology, 2:56668
Aamodt, R.E., *See* Hoffman, J.M., 2:57680
Abbott, W.H., *See* Gelles, S.H., 2:57092
Abdel-Khalik, S.I., First wall and blanket design for an ICTR, 2:57781
Heat transfer and stress problems associated with ICTR walls, 2:57782
Abdou, M.A., Impact of major design parameters on economics of Tokamak Power Plants, 2:57705
See Turner, L.R., 2:57734
Abduazizov, A., *See* Umarov, G.Ya., 2:56133, 2:56134
Abdullaev, T.B., *See* Kerimov, Z.G., 2:55766
Abel, G.P., Direct electric gas heating for gas turbines, 2:56279
Abidov, T.Z., *See* Umarov, G.Ya., 2:56095
Abner, C.H., *See* Shriner, D.S., 2:57351
Abramov, V.V., Results of the search for the intermediate W boson in proton-nucleus collisions at 70 GeV, 2:57565
Abrams, M., *See* Woodard, K., 2:56858
Abramson, P.B., *See* Pizzica, P.A., 2:56825
Abramson, R., Evolution of sodium purification: RAPSODIE, PHENIX, SUPER-PHENIX, 2:56484 (CONF-760503—P1, pp 51-59)
Achenbach, J.D., *See* Weertman, J., 2:56204
Achilov, B.M., *See* Norov, E.Zh., 2:56118
Ackerman, S., *See* Noble, J.B., 2:56582
Ackermann, N.J. Jr., Power plant surveillance and diagnostics research and development needs, 2:56364
Aczel, T., Studies on the organic structure of coals, 2:55635 (CONF-760885—, pp 165-173)
Adamovich, V.K., Ways to solve the problem of extending the service life of existing and projected steam pipelines beyond 100,000 hr, 2:57122
Adams, N.J.I., Analysis and prediction of failure in tubes, 2:57257
Adams, R.G., Design of turbomachinery for the gas turbine (direct cycle) high temperature gas cooled reactor power plant, 2:56439
Adams, R.W., Material control assessment procedure, 2:55966 (UCRL—79214)
Material control assessment procedure, 2:57384 (UCRL—79214(Rev.1))
Adams, S.A., *See* Chiang, R.N.S., 2:56108
Addington, D.V., *See* Briggs, D.E., 2:55613
Adelman, D.J., *See* Berg, M.E., 2:57240
Adler, N., Application of gel permeation chromatography to the examination of crude oil, 2:55801
Adler, P.N., Application of in situ analysis to hydrogen-related materials problems, 2:57337
Afrosimov, V.V., Absolute measurements of photon flux from a laser plasma in the vacuum ultraviolet, 2:57657
Local diagnostics of impurity ions in a hot plasma, 2:57637
Agapova, A.V., *See* Kleimenov, N.G., 2:56254
Agarwal, S.C., Void swelling in V-ion-irradiated V-O alloys, 2:57151
Aggarwal, S., Universally faithful transformations for ergodic machines, 2:57824 (UCRL—79308)
Agmon, T., Accommodation in the international capital markets and the recycling of oil funds. Working paper, 2:56917 (PB—265113)
Agrawal, A.K., *See* Quan, V., 2:56826
Ahlf, J., Irradiation and post-irradiation examination techniques for reactor pressure vessel steels at GKSS, 2:56764 (AED-Conf—76-556-013)
Ahlstrom, H.G., Laser fusion implosion and target interaction physics, 2:57771 (UCRL—79540)
Ahlstrom, S.W., *See* Arnett, R.C., 2:57397
Aikawa, K., Boric acid content of hot springs and river waters at Owakudani Valley, Volcano Hakone, 2:56192
Airapetyan, Yu.I., Investigation of operating conditions of nuclear power plants during emergency shortages of power in the electric power system, 2:56389
Aitken, D.W., "Solar switchboard": an interim analysis of an experiment in the dissemination of solar energy information to the public, 2:56021
Akebi, M., *See* Shibato, E., 2:56466
Akhababyan, N.O., *See* Angelov, N., 2:57571
Akilov, Yu.Z., Computer-aided calculation of insolation of rooms, taking into account different shading factors, 2:57830
Akimov, Yu.A., *See* Lokshin, V.A., 2:56315
Akino, F., Measurement of space dependent angular thermal neutron spectra in natural uranium-light water slab, 2:56649
Akita, J., Square through tube, 2:56699
Akkerman, G., Investigation of conditions of operation of nuclear power plants with water-cooled power reactors, 2:56394
Akopin, V.D., Elastic $\pi^+ p$, $K^+ p$, and pp scattering in the region of Coulomb-nuclear interference at momenta 42.5 and 52.2 GeV/c, 2:57569
Akutsu, H., Development of plutonium fuels in PNC, 2:56710
Al'tshuller, M.A., *See* Margulova, T.Kh., 2:56682
Alakseevskii, I.G., *See* Surkov, L.P., 2:55709
Alavutdinov, D.N., *See* Umarov, G.Ya., 2:56134
Albrecht, W., *See* Meier, H.U., 2:56999
Albright, D.C., Pipe rupture studies in the Clinch River Breeder Reactor, 2:56832
Alefeld, G., Methods for conveying and utilization of waste heat from power plants, 2:56341
Aleinikov, G.I., *See* Zubov, I.V., 2:56291
Aleite, W., Reactor capacity-control technique. Development of KWU/PWR's during the past 10 years and development tendencies, 2:56733
Aleksakhin, I.S., Absolute effective cross sections for the excitation of a strontium atom from metastable states by electron collision, 2:57515
Aleksandrov, A.M., Evaluation of the limit state of a cylinder and piston group of diesel engines, 2:57020
Aleksandrov, Y.A., Photoproduction of neutral pions from hydrogen at 320 MeV, 2:57562
Aleksapol'skii, D.Ya., Effect of the frequency of rotation on the efficiency of a centrifugal pump with a low n/sub s/, 2:56684
Alekseenko, D.V., *See* Bezrodnyi, M.K., 2:57264
Alger, D.M., *See* Tsang, F.Y., 2:57311
Algermissen, J., *See* Noetzold, D., 2:57247
See Oyegbesan, A.O., 2:55976
Allmov, A.K., *See* Umarov, G.Ya., 2:56095, 2:56133, 2:56134
Alire, R.M., Mathematical models for transport of tritium and helium-4 in solid breeders, 2:57765
Alkire, G.J., *See* Sheely, W.F., 2:56544
Allan, C.G., Activity deposition in DFR primary cold traps, 2:56482 (CONF-760503—P1, pp 35-43)
Impurity deposition in PFR plugging meters and cold traps, 2:56480 (CONF-760503—P1, pp 22-29)

Allemann, R.T., Evaluation of alternative dry/wet cooling concepts for power stations, 2:56345
See Zaloudek, F.R., 2:56236
Allen, A.O., *See* Bielski, B.H.J., 2:57235
Allen, A.W., Experimental and numerical studies of magnetohydrodynamic stability properties of a rectangular-cross-section finite-β toroidal plasma, 2:57671
Allen, E.L., *See* Whittle, C.E., 2:56741
Allen, G.C., *See* Pope, R.B., 2:57280
Allen, J.C., Method of in situ recovery of viscous oils and bitumens, 2:55838
Allison, C.M., *See* Quapp, W.J., 2:56808
Allison, T., User's guide to the LLL BASIC interpreter, 2:57816 (UCID—17090(Rev.1))
Alonso, B., *See* Martinez, J., 2:56056
Altes, J., *See* Kroeger, W., 2:56809
Altschuler, S.J., *See* Anders, O.U., 2:55921
Altvater, W., Iran-1 and Iran-2 nuclear power station on the Persian Gulf, 2:56413
Aluker, E.D., Formation and dissociation of F centers in a KCl crystal as a result of pulsed irradiation, 2:57187
Amamou, A., Ferromagnetic and antiferromagnetic coupling in amorphous (Ni/sub 100-c/Mn/sub c/)$_{75}$P$_{14}$B$_6$, 2:57127 (CALT—822-91)
NMR and Moessbauer studies of the amorphous system Fe$_{79}$P/sub 21-x/B/sub x/, 2:57101 (CALT—822-95)
Amendola, A., *See* Doetschmann, K., 2:56537
Ames, J., *See* Liu, M., 2:57357
Aminov, R.Z., Method of calculation of the optimum coefficient of industrial district steam heating, 2:57008
Amlas, A.M., *See* Landa, G.R., 2:56324
Amyot, L., *See* Boisvert, J., 2:56617
An, I.V., *See* Shpil'rain, E.E., 2:56998
An, S., *See* Oka, Y., 2:56564
Anagnostou, E., Real time outdoor exposure testing of solar cell modules and component materials, 2:56042 (ERDA/NASA/1022—77/10)
Anbar, M., *See* Scolnick, M.E., 2:55598
Anders, O.U., Leaching of solidified radioactive waste, 2:55921
Anderson, D.R., Trace metal toxicity in aquatic teleosts (fishes), 2:57454
See Talbert, D.M., 2:55928
Anderson, F.O., *See* Davis, J.W., 2:57314
Anderson, J.D., *See* Haight, R.C., 2:57594
Anderson, J.E., Pyrolysis process for converting refuse to fuel gas, 2:55993
Anderson, J.L., Tritium containment and cleanup technology in the Tritium Systems Test Assembly, 2:57758
See Sherman, R.H., 2:57753
Anderson, P.J., Status of world trade in liquefied natural gas, 2:55814 (CONF-770360—1)
Anderson, R.C., Impact of the Federal tax code on resource recovery. Final report, 2:56929 (PB—264886)
Anderson, R.L., *See* Franz, S., 2:56047
Anderson, T.T., *See* Sheen, S.H., 2:56817
Anderson, W.A., Schottky solar cells on thin epitaxial silicon, 2:56075
Ando, S., *See* Hosokawa, T., 2:56717
Ando, Y., *See* Susukida, H., 2:56674
Andreev, M.M., *See* Buglaev, V.T., 2:56301
Andreev, V.A., Thermal operation of double-bath steel-smelting furnaces, 2:57042
Andreeva, K.S., *See* Zinger, N.M., 2:57010
Andres, O., Cooling tower feedwater treatment for nuclear power plants, 2:56663
Andrews, L.S., Characterization and induction of aryl hydrocarbon [benzo(a)pyrene] hydroxylase in rabbit bone marrow, 2:57415
Andryushchenko, A.I., Problems and prospects of development of gas turbine power plants, 2:56276
Andryushin, V.M., *See* Kleimenov, N.G., 2:56254
Angelini, A., Absorber rod to control a nuclear reactor with a charge of spherical fuel elements, 2:56732
Angelov, N., Investigation of rho^0- and ω-meson production in π^- p interactions at 40 GeV/c, 2:57571
Two-particle correlations of charged particles and γ rays in π^- n interactions at momentum 40 GeV/c, 2:57570
Angerer, G., Dynamics of large waves during molten cladding film relocation, 2:56852
Anisimova, N.Z., *See* Abramov, V.V., 2:57565
Annsnazarov, M., *See* Rakhmanov, A., 2:56101
Anno, J.N., Radiation cleanup of vacuum systems (radiation-induced outgassing). Progress report, September 15, 1976—September 14, 1977, 2:57787 (COO—4093-1)
Anokhin, V.M., *See* Kapel'son, L.M., 2:56312
Anon, Drilling/exploration activities, 2:57464
Safety aspects in offshore design, 2:55780
Anthes, J.P., Direct observation of the dynamics of picosecond-pulse optical breakdown, 2:57183
Antikain, P.A., Steel grades for tubes of heating surfaces of high-capacity highly efficient boilers, 2:57132
Antisiferov, A.S., Formation of oil and gas pools and technique for their exploration in southern regions of Siberian platform, 2:55753
Antonov, E.I., *See* Kulichikhin, V.V., 2:56287
Antonov, O.N., *See* Ol'khovskii, G.G., 2:56333
Aoki, K., *See* Ueda, M., 2:56472
Aoki, T., PURSE: plutonium radiation source code, 2:55868 (PNCT—841-75-37)
Aono, S., Air-fuel ratio control system for use with internal combustion engine, 2:57084
Aparisi, R.R., Utilization of solar radiation at large solar power plants with hydraulic storage, 2:56083
Apatovskii, L.E., *See* Mitor, V.V., 2:56316
Apostolakis, G.E., *See* Chun, J., 2:56791, 2:56862
See Wu, J.S., 2:56790
Appel, B.R., The chemistry, dispersion and transport of air pollutants emitted from fossil fuel power plants in California: chemical analysis of particulate samples for sulfate, nitrate, and trace element composition. Final report, Sep—Nov 1974, 2:57358 (PB—264823)
Arakelyan, E.K., *See* Kiselev, G.P., 2:56253
Arbuzov, B.A., Weak interaction of colored hadrons, 2:57576
Ardentov, V.V., *See* Paton, B.E., 2:57097
Arkad'ev, B.A., Effect of the throughput capacity of nozzle cascades on the economic efficiency and reliability of a turbine installation, 2:56318
Using sliding live steam pressure to control the capacity of power units of nuclear power plants, 2:56664
Arkad'ev, D.A., *See* Karpin, E.B., 2:56274
Armani, R.J., *See* Duffey, D., 2:57192
Armbruster, P., *See* Mokler, P.H., 2:57542
Arnett, R.C., Hanford groundwater scenario studies, 2:57397 (ARH-SA—292)
Arnold, G., First-rate prestressed concrete structures in underground workings: oceanic buildings, nuclear power plants, containers and tunnels, 2:56706
Aron, W., *See* Fullwood, R.R., 2:55948
Aronstein, R.E., Cost components of fusion plant design, 2:57704
Arora, J.L., High- and low-Btu gas from Montana subbituminous coal, 2:55564 (CONF-770814—3)
Arp, V.D., *See* Jones, M.C., 2:56360
Arsen'ev, L.V., *See* Kirillov, I.I., 2:56332
Artem'ev, V.A., *See* Kopylov, I.P., 2:56309
Artus, S.C., Gamma heated subassembly for sodium boiling experiments, 2:56794 (TID—27639)
Arulpragasam, I., *See* Lam, S.T., 2:57154
Arunasalam, V., *See* Davis, S.L., 2:57632
See Hosea, J., 2:57685
Arutyunyan, S.G., Investigations related to the calculation of steady-state conditions of electric systems comprising long ac and dc electric power lines, 2:56358
Asahi, Y., HYDY-B1 CODE: calculational model for core thermo-hydraulics during a loss-of-coolant accident, 2:56782 (JAERI-M—6539)
Asami, K., Method of detecting and correcting reactor water level, 2:56406
Asay, J.R., *See* Lawrence, R.J., 2:57117
Ash, J.E., Coupling of the structural and coolant response in a single core subassembly model, 2:56839
Ashcroft, N.W., *See* Wood, D.M., 2:57169
Ashley, T.S. III, *See* Moore, C.S., 2:56140
Ashworth, R.A., Utilization of low and intermediate Btu gas from coal for iron ore pelletizing. Open file report, Jul 1975—Mar 1977, 2:57094 (PB—264702)
Asman, W.A.H., Bibliography on precipitation chemistry (subject index), 2:57350 (NP—21685)
Asquith, J.G., Design of the FFTF fuel storage facility (FSF), 2:56760
Ast, D.G., Influence of grain boundaries on the electrical transport properties of polycrystalline Si films. Progress report, 2:57174 (COO—2899-1)
Atkinson, G., Changes in the petrol retailing movement, 2:55787
Atsumo, H., *See* Kanoh, S., 2:56496
Auer, I.P., Measurement of the π^+ p and π^- p polarization parameters at 100 GeV/c, 2:57567
Auerbach, S.I., Current perceptions and applicability of ecosystem analysis to impact assessment, 2:57376 (CONF-770228—1)
Aungst, R.C., *See* Johnson, R.N., 2:56492
Austin, L.G., Study of the mineral matter distribution in pulverized fuel coals with respect to slag deposit formation in boiler furnaces: Phase 1. Interim report, July—September 1976, 2:55642 (FE—2316-2)
Auxier, J.A., Radiation safety, 2:57428 (CONF-770615—2)
Avdeichikov, V.V., Inelastic interaction of high energy particles with light nuclei and the cluster structure of nuclei, 2:57593
Azaev, G.A., Molding of a low-temperature catalyst for methanol synthesis, 2:55995
Azekura, K., *See* Takeda, T., 2:56650

B

Babiyuk, G.V., Control of stress distribution around mine workings, 2:55708
Babkin, G.V., Experimental investigation of a discharge in a high-current coaxial plasma source, 2:57658
Bach, C.W., *See* Carelli, M.D., 2:56530
Bachl, H., Gas-cooled nuclear reactor with a pressure vessel with liners, 2:56444

Backhaus, H., Small ammonia plants: prospects for natural-gas utilization in developing countries, 2:55810
Badham, V., Accidental criticality of fusion/fission hybrid blanket designs, 2:57745
Badur, A., Consequences of ultimate sequences of HTGRs, 2:56804
Baechler, U., Articulated trams '2000 series' of the Zurich municipal transport authority, 2:57026
Bagnall, C., *See* Shiels, S.A., 2:56524
Bahrani, A.S., *See* Crosaland, B., 2:56679
Bahre, K., Coal planer, 2:55676
Baibakova, N.N., *See* Zakhidov, R.A., 2:56124
Baikov, A.B., Reductions of the maximum combustion pressure of high-speed diesel engines with high supercharging, 2:57018
Baisden, P.A., Nuclear magnetic resonance studies of diamagnetic metal—aminopolycarboxylate complexes, 2:57229
See Hulet, E.K., 2:57601
Baker, G.A. Jr., Convergence of rows of the Pade table, 2:57829
Baker, J.P., Study of low-frequency excess noise in hybrid thick-film resistors, 2:57315 (ORNL/Sub—3961/2)
Baker, M., Double scattering in deuterium as a probe of hadron structure, 2:57583
Baker, R.D., Examination of fast reactor fuels, FBR analytical quality assurance standards and methods, and analytical methods development: irradiation tests. Progress report, January 1—March 31, 1977, 2:56539 (LA—6808-PR)
Baker, R.W., Estimating wind power potential, 2:56226
Bakker, A., *See* Spaas, H.A.C.M., 2:56384
Bal'chuk, V.S., *See* Shkarbul', S.N., 2:56270
Balandin, Yu.F., Prospects of improving pearlitic steels for reactor shells and other equipment of the first loop of nuclear power plants, 2:56694
Balashov, N.A., Experimental investigation of vibration regimes of combustion in combustion chambers of the U-25 plant, 2:56994
Baldis, H.A., *See* Burnett, N.H., 2:57683
Balezin, S.A., Protection of boiler steels from corrosion in solutions of trilon b and organic acids at temperatures of 100-170°C, 2:56256
Balgurov, E.V., *See* Gal'perin, M.I., 2:56009
Balinov, I.M., Feed system of a coal getting combine, 2:55670
Balovnev, Yu.A., Mechanism of the oxidation of hydrogen on platinum, 2:55978
Baltisberger, R.J., *See* Woolsey, N.F., 2:55620
Balykov, V.M., *See* Balinov, I.M., 2:55670
Bamford, W.H., Statistical methods for interpreting fatigue crack growth data with applications to reactor pressure vessel steels, 2:56677
Banerjee, A., *See* Das, S.R., 2:56051
Banerjee, S., Uranium requirements for fuel cycles in expanding nuclear power systems, 2:55895
Banerjee, S.P., *See* Maung, H.M., 2:55699
Bankoff, S.G., Mechanisms of vapor explosions. Technical progress report, October 1976—March 1977, 2:56532 (COO—2512-10)
Bar-Yam, Z., *See* Stein, N.A., 2:57566
Baranov, V.K., Combination of photo cones and photo wedges with radiation receivers, 2:56122
Methods of calculation of profiles of focusing cones and focusing wedges, 2:56128
Baranov, Yu.E., *See* Buryachko, B.P., 2:57052
Barber, J., *See* Allison, T., 2:57816
Barbucci, P., Exponential supplementary equations for S/sub N/ methods: the one-dimensional case, 2:56642
Barchewitz, E., *See* Baumgaertner, H., 2:56612
Bardisashvili, A.B., *See* Khairiddinov, B., 2:56104
Bardsley, J.N., Theory of low-energy electron-atom collisions and related processes, 2:57524
Barl, R.A., Meltdown phase for an LMFBR loss of heat sink during shutdown, 2:56828
See Albright, D.C., 2:56832
See Tsai, S.S., 2:56823
Barish, S.J., Inclusive γp and γn charged-current neutrino reactions below 6 GeV, 2:57564
Barker, R.F., *See* Hopkins, D.R., 2:55887
Barnert, H., *See* Schulten, R., 2:56614
Barnes, V.E., *See* Barish, S.J., 2:57564
Barnett, A.M., Advances in the development of efficient thin film CdS/Cu_2S solar cells, 2:56044 (TID—27697)
Barnett, C.F., Atomic physics in the controlled thermonuclear research program, 2:57646
Baron, B., *See* Burton, L.C., 2:56028
See Meakin, J.D., 2:56070
Baron, I.M., *See* Chang, A.L., 2:57119
Baronkin, Yu.F., *See* Nudel', A.M., 2:56686
Barosh, P.J., Relationship of seismicity to geology in the Northeastern United States, 2:57469
Barrett, R.J., *See* Kidman, R.B., 2:56982
Barron, J.A., *See* Green, H.P., 2:55604
Barsell, A.W., *See* Chawla, O.P., 2:56775
Barskii, I.A., Reduction of fuel consumption of a two-shaft gas turbine engine in idle run, 2:57326
Bartel, J.J., *See* Green, R.M., 2:56154
Bartine, D.E., *See* Burns, T.J., 2:56548
Bartlett, J.W., Perspectives on risk assessment for radioactive waste management systems, 2:55942
Bartlit, J.R., *See* Sherman, R.H., 2:57753
Barts, B.I., *See* Inopin, E.V., 2:57616
Barts, E.W., *See* Eberhart, J.G., 2:56766
Bartsch, R.R., Feedback stabilization experiments using $l = 2$ equilibrium windings in Scyllac, 2:57661 (LA-UR—77-1142)
Bartuska, V.J., ^{13}C NMR studies of solid coal samples, 2:55639 (CONF-760885—, pp 220-228)
Basford, R.C., The design of a solar energy collection system to augment heating and cooling for a commercial office building, 2:56098 (N—77—16446)
Bashkin, S., *See* Griffin, P.M., 2:57219
Basin, S.L., Characteristics of pipe system failures in light-water reactors, 2:56861
Basmajian, J.A., Correlation for boron carbide helium release in fast reactors, 2:56724
See Hollenberg, G.W., 2:56725
Bass, M., *See* Anthes, J.P., 2:57183
Basu, D.K., Improved nucleate boiling design equation, 2:56648
Bathke, C., *See* Choi, C., 2:57648
Bathke, C.G., Optimization process in the PPL hybrid study, 2:57710
Batmanov, Yu.K., Bearing pressure as a factor reducing seam burst hazards, 2:55738
Batts, L.R., *See* Flott, A.C., 2:57023
Bau, R., *See* Koetzle, T.F., 2:57209
Baublitz, J.E., Overview of the MFE/ERDA Environment and Safety Program, 2:57757
Bauer, E., *See* Schwarz, F., 2:55769
Bauer, M.I., *See* Mrochek, J.E., 2:57201
Bauerle, G., Storage of solar energy by inorganic oxide/hydroxides, 2:56163
Baumbach, G., Lowering of pollutant content in emissions from fuel combustion in boilers of middle capacity, 2:55791
Baumgaertner, H., Plant for producing hydrogen by utilizing the thermal energy generated in a gas-cooled high-temperature reactor, 2:56612
Bavel'skii, D.M., Use of holography in power engineering, 2:56314
Bax, J.D., Advanced drillship for deep water operations, 2:55761
Bayfield, J.E., Production and detection of highly excited states, 2:57508
Baylac, G., Thermoplastic analysis of a pump body in a primary circuit nuclear application, 2:56419
Bayler, T., Fuel economy improvement through diagnostic inspection. Technical report, 2:57053 (PB—265064)
Bazant, Z.P., *See* Weertman, J., 2:56204
Bazarov, B.A., Experimental setup to measure spatial and energetic characteristics of solar concentrators, 2:56129
Bazargui, A., Compressibility and compliance of spiral wound gaskets, 2:56464
Beall, A.O. Jr., Dynamics of petroleum industry investment in the North Sea. (World Oil Project), 2:56971 (PB—265093)
Beard, J.T., Engineering analysis and testing of water-trickle solar collector, report No. 3. Progress report, June 1975—November 1976, 2:56120 (ORO/4927—77/1)
Beardsworth, E., Potential need for fusion in the U.S. energy system, 2:57702
Beauchamp, J.L., Reaction mechanisms of organic and inorganic ions in the gas phase, 2:57220
Beaumont, E.C., Guidebook to coal geology of northwest New Mexico. Circular 154, 2:55659 (NP—22279)
Beavan, L.A., Irradiation effects in boronated graphite, 2:56727
Beck, H.L., External environmental radiation levels from natural sources, 2:57369
Becker, F.I., *See* Morgan, W.C., 2:56427
Beckurts, K.H., Experience in transfer of nuclear technology, 2:56635
Bednarska, J., *See* Sablik, J., 2:55716
Bedrik, B.G., *See* Gulin, E.I., 2:57062
Beecher, M.E., Solar energy collection at Arizona State University, 2:56020
Behling, D.J. Jr., Overview of technological-economic models for energy policy analysis, 2:56954 (BNL—22730)
Behrens, J.W., *See* Carlson, G.W., 2:57605
Behrens, R. Jr., *See* Parr, T.P., 2:57511
Behrisch, R., Sputtering of niobium by energetic neutrons and protons: A round-robin experiment, 2:57494
Bein, M., Model to predict core pressure during a transient overpower (TOP), 2:56831
Bekowies, P.J., *See* Novakov, T., 2:57355
Belan, F.I., *See* Zubov, I.V., 2:56291
Belik, V.P., *See* Afrosimov, V.V., 2:57657
Belikov, V.S., Thermonuclear cyclotron magnetosonic instability of plasma, 2:57673
Bell, F., *See* Betz, H.D., 2:57543
Belokurova, I.N., Influence of irradiation on copper- and antimony-doped germanium, 2:57152
Beloshitsky, V.V., *See* Nikolaev, V.S., 2:57539
Belov, A.I., *See* Ol'khovskii, G.G., 2:56288
Belyaev, V.I., Effect of land value on construction costs of thermal and nuclear power plants, 2:56365
Belyakov, V.M., *See* Kulichikhin, V.V., 2:56287
Bencic, B., Possibility of selecting the most economical pour point depressant from the user's standpoint, 2:55770

Bender, C.F., SCF-stabilization approach to excited states embedded in the continuum, 2:57554
Bender, D.J., Reference mirror hybrid fusion-fission reactor design, 2:57713
Review of the mirror hybrid reactor, 2:57690 (UCRL—79548)
Bender, F.E., Solar energy applications in agriculture: potential, research needs, and adoption strategies, 2:56092 (PB—265105)
Bendig, D.J., *See* Nielsen, S.O., 2:55929
Benedek, R., Relationship between defect resistivity and bulk resistivity at the melting temperature, 2:57130
Bennington, G., Comparative analysis of solar energy applications to the year 2000 and beyond, 2:56015
Benoist, E., Experience with sodium purification on large-scale operational test loops in France, 2:56487 (CONF-760503—P1, pp 75-82)
Benson, S., *See* Stein, S., 2:55634
Bentley, P.G., Calculation of basic resonances for acoustic vibration in fast reactors, 2:56568
Berdahl, P., Analysis of the California solar resource, 2:56138
Beretta, F., Investigation of visible and ultraviolet emission from fuel oil flames on an industrial scale, 2:57318
Berg, L., Catalytic hydrogenation of coal-derived liquids. Interim report, March 1977—May 1977, 2:55556 (FE—2034-7)
Berg, M.E., Gas to liquid to solid transition in halogen hot atom chemistry. IV. The suggestion of multiple enhancement reactions in high energy iodine-128—ethane systems, 2:57240
Berger, D., *See* Chance, M.S., 2:57663
Berger, R.H., *See* Munis, R.H., 2:57003
Berkner, K.H., Cryopump, neutral-beam compatibility test, 2:57798
Berkovich, A.L., *See* Kirillov, I.I., 2:56332
Berkovich, Ya.D., *See* Ivanov, V.A., 2:56299
Berlin, J.K., *See* Loughran, E.D., 2:57345
Berlin, M., *See* Fruchard, Y., 2:56580
Berlin, R.E., *See* Robertson, C.G., 2:55925
Berlyand, V.I., Effect of rigidity and damping of bearings on the value of threshold capacity of self-exciting vibrations of steam turbine rotors, 2:56340
Berman, B.L., Isospin shift of the energy of the giant resonance, 2:57612
Berna, G.A., *See* Dearien, J.A., 2:56369
Bernard, L.C., *See* Chance, M.S., 2:57663
Bernardini, C., Design and tests of flat-plate solar collectors, 2:56121
Berndt, M., Catalytical removal of nitrogen oxide exemplified by a large plant, 2:55809
Bernnat, W., *See* Dinkelacker, A., 2:56750
Berther, M., Some aspects of the cryogenics of a superconducting generator, 2:57270
Bertozzi, G., *See* Girardi, F., 2:55951
Bethel, J.S., Biological productivity of renewable resources used as industrial materials, 2:56926 (PB—264457)
Fibers as renewable resources for industrial materials, 2:56928 (PB—264561)
Reference materials system: a source for renewable materials assessment, 2:56927 (PB—264494)
Bettis, E.S., *See* Uckan, N.A., 2:57714
Betz, H.D., Radiative and nonradiative electron capture from and into outer and inner shells in heavy ion-atom collisions, 2:57543
Betz, W., Important problems in future heavy ion atomic physics, 2:57557
Beuhler, R.J., Model of secondary electron yields from atomic and polyatomic ion impacts on copper and tungsten surfaces based upon stopping-power calculations, 2:57495
Bevilacqua, F., *See* Jones, T.A., 2:56656
Bezrodnyi, M.K., Investigation of heat exchange when liquids are boiled in closed two-phase thermosiphons, 2:57264
Bhargava, B., *See* Hudis, M., 2:56349
Bian, S., Determination of plasma parameters in a fusion system, 2:57634
Biederman, N., *See* Konopka, A., 2:56089
See Yudow, B., 2:56091
Bieger, W., *See* Martin, C., 2:57654
Bielski, B.H.J., Mechanism of the disproportionation of superoxide radicals, 2:57235
Bienert, W.B., Heat pipes applied to flat-plate solar collectors. Final report, 2:56119 (COO/2604—76/1)
Bierman, S.R., Reactivity measurements under conditions typical to fuel element dissolution, 2:55886
Bigeleisen, J., Quantum mechanical foundations of isotope chemistry, 2:57225
Bilalov, Ya.M., *See* Buniyat-Zade, A.A., 2:57172
Billau, R., *See* Buchan, R.M., 2:56097
Billon, F., *See* Phan-Ngoc, K., 2:56418
Bilton, J.R., Some interesting engineering problems in TFTR design, 2:57790
Birchenall, C.E., Thermal storage in metals, 2:56160
Birkhofer, A., Theoretical fundamentals for the SAFTL and CRESS program system to calculate system reliability, 2:56877 (NP-tr—1977)
Birkhoff, R.D., *See* Heller, J.M. Jr., 2:57221
Birney, K.R., Absorber materials for fast reactor control applications, 2:56723
Birsic, R.J., More about geothermal steam or the hottest energy prospect ever, 2:56172
Birss, E.W., Comparison of the extended set theory and relational approaches to data base management, 2:57833 (UCRL—79357)
Bischel, W.K., Study of momentum transfer distributions in rotationally inelastic collisions, 2:57551
Biswas, S.C., Activation energies of carbonization of coals, 2:55549
Bitler, J., Environmental control problems, 2:56896
Bitterlich, E., Storage of steam in off-peak periods for application during peak demands, 2:56343
Black, S.A., *See* Huff, J.E., 2:57445
Blackshear, P.L. Jr., *See* Riaz, M., 2:56159
Blackwell, B.F., Wind tunnel performance data for two- and three-bucket Savonius rotors, 2:56222 (SAND—76-0131)
Blagoveshchenkii, V.V., Some aspects of the problem of control of Kaluga Turbine Plant turbines with generators of a new series, 2:56336
Blais, P.D., *See* Hopkins, R.H., 2:56032
Blake, M.I., *See* Katz, J.J., 2:57438
Blanco, R.E., *See* Pechin, W.H., 2:55936
Blander, M., Equations of state for alkali metals near their critical points, 2:57128 (CONF-770537—4)
See Renner, T.A., 2:57231
Blauvelt, R.K., *See* Griffin, J.F. Peterson, J.B., 2:57277
Bleiberg, M.L., *See* Chang, A.L., 2:57119
Bliss, C., Accidents and unscheduled events associated with non-nuclear energy resources and technology. Final report, 2:56923 (PB—265398)
Blocher, J.M. Jr., Evaluation of selected chemical processes for production of low-cost silicon (Phase II). Silicon Material Task, Low-Cost Silicon Solar Array Project. Fifth—sixth quarterly progress report, October 1, 1976—March 31, 1977, 2:56033 (ERDA/JPL/954339—77/1)
Block, J.A., Effect of superheated walls on plenum filling at 1/15 scale. Quarterly progress report, October 1, 1976—December 31, 1976, 2:56773 (CREARE-TN—255)
Bloemen, H.A., BOBL code. Experimental verification of the hydraulic model, including effects of pin bowing and grids, 2:56536 (ECN—9)
Bloomster, C.H., Analysis of electricity production costs from the geopressured geothermal resource, 2:56194 (BNWL—2192)
Blum, H.A., *See* Moore, C.S., 2:56140
Blum, K., *See* Kleinpoppen, H., 2:57546
Blume, J.A., Realistic seismic safety for nuclear plants, 2:56745
Blumm, M.C., *See* Noble, J.B., 2:56582
Boade, R.R., *See* Reed, R.P., 2:55832
Bobashev, S.V., *See* Afrosimov, V.V., 2:57657
Bobbett, R.E., Passive electronic identification and temperature monitoring system. Progress report, January—December 1976, 2:57340 (LA—6812-PR)
Bober, M., Evaporation studies of liquid oxide fuel at very high temperatures using laser beam heating, 2:56774 (EURFNR—1400)
Bobis, J.P., *See* Carey, W.M., 2:56816
See Sheen, S.H., 2:56817
Bocchini, G.F., Comparison of energy needs between conventional technologies and powder metallurgy, 2:57038
Bochkarev, G.R., Feasibility of using electrochemical coagulation to purify mine water, 2:55653
Bodily, D.M., Reactions of zinc chloride and coal, 2:55632 (CONF-760885—, pp 59-71)
Bodrov, I.S., *See* Kirillov, I.I., 2:56332
See Ol'khovskii, G.G., 2:56333
See Tyryshkin, V.G., 2:56313
Boedecker, K.W., Inservice inspections of primary components on the nuclear power plant Obrigheim, 2:56417
Boeer, K.W., CdS/Cu_2S heterojunction model, 2:56072
Sharing the Sun: solar technology in the seventies. Volume 8. Storage, water heater, data communication education. Contains sections 13.1, 13.2, 13.3, 15, 16, 5, 2:56016
Sharing the Sun: solar technology in the seventies. Volume 6. Photovoltaics and materials. Contains sections 7 and 12, 2:56059
See Meakin, J.D., 2:56070
Boehlje, M., Economics of mining coal in Iowa, 2:55731 (IS-ICP—46)
Boenig, F.H., *See* Adams, R.G., 2:56439
Bogachko, Yu.N., *See* Zubov, I.V., 2:56291
Bogatin, V.I., *See* Avdeichikov, V.V., 2:57593
Bogatyrev, Yu.M., *See* Trusov, L.P., 2:56255
Bogdanov, B.I., Development of promising designs of pistons for boosted modifications of diesels of the chn21/21 type, 2:57054
Bogomaz, V.I., *See* Livshits, M.A., 2:56294
Bogomolova, T.V., *See* Troyanovskii, B.M., 2:56285
Boguslavskii, V.B., *See* Gruzdev, N.I., 2:56379
See Margulova, T.Kh., 2:56682
Bohannon, J.R., *See* Stam, E., 2:56625
Bohn, M.P., *See* Dearien, J.A., 2:56369
Bolarski, A.A., *See* Luce, R.G., 2:56988
Bolko, V.N., *See* Glushko, V.V., 2:55747
Boissy, G.J., Preparing for electrical-system startup at a nuclear power plant, 2:56415

Boisvert, J., Development of the Nuclear Engineering Laboratory of Ecole Polytechnique, 2:56617
Bollinger, G.A., Earthquake activity in the Southeastern United States, 2:57471
Bolotin, Y.L., *See* Inopin, E.V., 2:57616
Bolstad, J.W., Analysis of Standard Problem 2 with the TRAC-1D Code, 2:56812
Bonamer, D.G., *See* Ashworth, R.A., 2:57094
Bond, W.H., *See* Luthy, D.F., 2:55901
Bondarenko, G.B., *See* Abramov, V.V., 2:57565
Bondarenko, V.T., Mastering the process of cold bending of pipes for a small radius in Soviet boilermaking, 2:57098
Bonewitz, R.A., Application of aluminum alloys for solar heating and cooling systems, 2:56144
Booth, L., *See* Devaney, J., 2:57764
Booth, L.A., *See* Frank, T.G., 2:57774
Borders, J.A., Use of $^{13}C(d,p)^{13}C$ and $^{16}O(d,p)^{17}O$ reactions, 2:57189 (SAND—77-0366C)
Bordina, N.M., Determination of the diffusion length of nonbasic carriers in the base of silicon solar cells, 2:56052
Determination of parameters of the current-versus-voltage characteristic of solar cells, 2:56053
Method of determination of operational values of electrical parameters of solar batteries, 2:56054
Bordzilovskii, S.A., Shock compression of liquid hydrogen in various experimental geometries, 2:55979
Borgonovi, G.M., Resource utilization of symbiotic HTGR systems, 2:56434
Borgstedt, H.U., Corrosion and creep of pressurized stainless-steel tubes in liquid sodium at 873 and 973°K, 2:56542
Influence of sodium on the mechanical properties of fuel element cladding, 2:56519 (CONF-760503—P1, pp 331-337)
Borisov, A.V., Directions and tasks of oil exploration in the southern part of Timan-Pechora province for 1976-1980, 2:55807
Borisov, E.I., Power industry in the first year of the tenth five-year plan period and the tasks for 1977, 2:56979
Borissova, N.A., *See* Krentsel, B.A., 2:55773
Borog, V.V., Inelastic interaction of muons with Fe nuclei at small Q^2 in the energy region above 200 GeV, 2:57596
Borovansky, V.T., Solar energy information system (a proposal), 2:56019
Borovkov, A.I., Investigation of surge protection of compressors of gas turbine power plants, 2:56335
Borovkov, V.M., *See* Ivanov, V.A., 2:56299
Bos, L., *See* Kolster, B.H., 2:56522
Bossi, R.H., Modulation transfer functions for high-speed-motion neutron radiography systems, 2:57312
Botneva, T.A., *See* Maksimov, S.P., 2:55742
Bott, T.F., Influence of equation-of-state uncertainties on fuel vapor expansion work-energy calculations, 2:56847
Botts, T., Waste management procedures for CTR central power stations, 2:57762
Bourque, R.F., Parametric and economic analysis of tokamak reactors with elongated plasmas, 2:57708
Bourquin, R.D., *See* Birney, K.R., 2:56723
Boutefeu, A., *See* Espitalie, J., 2:55746
Bowen, D., *See* Taylor, R.W., 2:57212
Bowen, V.T., Oceanic distributions of radionuclides from nuclear weapons testing, 2:55927
Bowersox, D.F., Reaction between plutonium and deuterium. Part II. Rate measurements by weight changes, 2:57241 (LA—6681-MS)
Bowman, B.R., Reactor containment analysis for BWR suppression systems. Progress report for January—March 1977, 2:56795 (UCRL—50045-77-1)
Boyd, D., *See* Lim, C.B., 2:57425
Boyd, R.W., Infrared upconverter for astronomical imaging, 2:57341
Boyer, A.F., Future of the coal byproducts industry, 2:55589
Bozhko, A.E., Setting up vibration reliability testing systems for parts and units of power plant equipment, 2:56329
Bracewell, R.N., *See* Swanson, R.M., 2:56030
Bradley, E.B., *See* Reucroft, P.J., 2:55574
Bradley, E.R., Depth distribution of damage in ion-bombarded molybdenum, 2:57147
Bradley, R.A., Preparation of fuel elements for high temperature gas cooled reactors, 2:56457
Bradley, W.L., *See* Olson, D.L., 2:57133
Brailsford, A.D., Effect of implanted interstitials on swelling during self-ion bombardment, 2:57145
Braitsev, A.V., Terminology and classification of qualitative characteristics of coal mines, 2:55697
Bramlette, T.T., *See* Green, R.M., 2:56154
Brandberg, S., *See* Linder, P., 2:55946
Bratuta, E.G., *See* Arkad'ev, B.A., 2:56318
Brau, C., Simple, pulsed, electron beam gun, 2:57496
Braun, D.J., Engineering and cost comparison of three different all-dry cooling systems, 2:56241
See Braun, D.J., 2:56241
Braun, J.D., Role of the engineer in protecting personnel and the environment in the nuclear industry, 2:57273 (MLM—2438(OP))
Brawer, S.A., Optical properties of trivalent chromium in silicate glasses: A study of energy levels in the crossing region, 2:57179
Brayshaw, D.D., Three-body mechanism for narrow resonances, 2:57578
Brecht, S.H., *See* Hitchcock, D.A., 2:57670
Brehm, W.F., Radioactive corrosion product transport and control, 2:56511 (CONF-760503—P1, pp 263-270)
Breiner, S., Gamma-ray measurement and data reduction considerations for airborne radiometric surveys, 2:55859
Breitung, W., Evaporation kinetics of oxide fuels and their effect on the actinide redistribution in reactor fuel pins and on fuel vapor pressure under accident conditions, 2:56878 (EURFNR—1370)
See Bober, M., 2:56774
Brenner, H., Synthoil hydrodynamics. Final report, 2:55600 (COO—0056-4)
Bresson, J., *See* Darcemont, M., 2:57165
Breus, T.K., *See* Gringauz, K.I., 2:57489
Brient, C.E., *See* Fischer, A.K., 2:57497
Briggs, D.E., Physical and chemical behavior of liquefied coal in solids separation. Quarterly report, January—March 1977, 2:55613 (FE—2550-2)
Briggs, J.S., Theory of inner-shell excitation in slow ion-atom collisions, 2:57537
Brimhall, J.L., Damage profile in molybdenum bombarded with Ni^{++} and (Ni^{++} + He^{+}) ions, 2:57146
See Bradley, E.R., 2:57147
Brockmann, C.E., General study of the region of Lake Titicaca, Bolivia, using a satellite multispectral scanning system. Petrologic study of metamorphic rocks in the Zongo Valley in Bolivia. Installation project of a bacteria in the Los Monos Plains. Geological study of the Ulla Charzani region, 2:57463 (E—76-10453)
Brodzinski, R.L., *See* Behrisch, R., 2:57494
Broekhoven, M.J.G., Fatigue and fracture behaviour of cracks at nozzle corners: comparison of theoretical predictions with experimental data, 2:57260
Brogli, R.H., *See* Borgonovi, G.M., 2:56434
Brolin, T., Considerate steelmaking helps cut steel costs, 2:57046
Bromberg, J.P., Measurement of absolute collision cross sections of electrons elastically scattered by gases, 2:57520
Bronshtein, I.M., Investigation of plasmon excitation by oblique incidence of a beam of primary electrons of medium energy in reflection experiments, 2:57498
Brook, N., Model studies of mine roadway deformation, 2:55679
Brooks, J.N., *See* Abdou, M.A., 2:57705
See Stacey, W.M. Jr., 2:57800
Brown, C.A., Combined seismic-LOCA mechanical evaluation for Exxon Nuclear 15 x 15 reload fuel for Westinghouse PWR's, 2:56797 (XN—76-47(NP))
Brown, D.L., *See* Potter, R.W. II, 2:56208
Brown, W.M., Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Economic issues affecting the development of a coal liquefaction industry. Final report, January 1975—December 1976, 2:55608 (FE—1752-21)
See Candela, B.J., 2:55603, 2:55606
Browning, M.F., *See* Blocher, J.M. Jr., 2:56033
Bruce, R.W., *See* Watson, M., 2:56081
Bruecher, H., Contributions to the risk evaluation of a high-level waste solidification plant, 2:55947
Brueckner, W., *See* Auer, I.P., 2:57567
Brugger, R.M., Production of 14 MeV neutrons by heavy ions, 2:57802
See Tsang, F.Y., 2:57311, 2:57602
Bruggisser, A., *See* Zubler, R., 2:56259
Brumovsky, M., Initiation and arrest: two approaches to pressure vessel safety, 2:56873
Brunot, W.K., Engineer's opinion of the Vermont Yankee court decision, 2:56742
Bry, R., Time for reality, 2:57069
Bryan, P.N., *See* Zama, M., 2:57411
Brzuskiewicz, J., *See* Gilligan, J.E., 2:56146
Buchan, R.M., Toxicological evaluation of liquids proposed for use in direct contact liquid—liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867—1)
Buchanan, J.R., Bibliography of reports on research sponsored by the NRC Office of Nuclear Regulatory Research, July—December 1976, 2:56786 (ORNL/NUREG/NSIC—135)
Buderkevich, M.D., *See* Glushko, V.V., 2:55747
Budinscak, V., *See* Adler, N., 2:55801
Budzhenko, A.I., Calculation of processes in the gas dynamic exchanger for diesel engine supercharging, 2:57055
Buglaev, V.T., Heat transfer during steam condensation on tube bundles of alternating slope and different directions of flow supply, 2:56301
Buhrman, R.A., *See* Craighead, H.G., 2:57168
Bujas, R., Method and device for the fabrication of nuclear fuel compacts, 2:55870
Bukharov, V.P., *See* Livshits, M.A., 2:56294

Bulaga, N.A., *See* Dunskii, V.D., 2:56295
Bull, S.R., *See* Schlapper, G.A., 2:57423
Bullough, R., Systematic approach to the radiation damage problem in fission and fusion reactor structural alloys, 2:57143 (UWFDM—184)
Bumarskov, A.O., *See* Ol'khovskii, G.G., 2:56288
Bunce, W.R., *See* Christenson, J.M., 2:56628
Buniyat-Zade, A.A., Investigation of the process of extrusion of medium-pressure polyethylene-based tubes in connection with the prospect of their utilization in Azerbaijan oil industry, 2:57172
Buonassisi, C.E., Practical meaning of energy management, 2:56943
Bura, L., Effect of support on an inclined measuring tank on the load on measuring probes of batching tank scales in a skip pit bottom, 2:55717
Burdick, G.R., *See* Wilson, J.R., 2:56865
Burk, E.H. Jr., Investigations on the nature of preasphaltenes derived from solvent refined coal conversion products, 2:55633 (CONF-760885—, pp 86)
Burkhart, R.L., *See* Morgan, K.Z., 2:57431
Burmistrov, A.I., *See* Landa, G.R., 2:56324
Burnett, N.H., Backscatter and beam refraction in underdense gas breakdown with nanosecond CO_2 laser, 2:57683
Burnham, K.B., *See* Arora, J.L., 2:55564
Burns, E.T., *See* Basin, S.L., 2:56861
Burns, T.J., Feasibility of denatured LMFBRs, 2:56548
Burrows, T.W., *See* Rose, P.F., 2:57588, 2:57589
Burson, Z.G., Radiation levels in the vicinity of ERDA facilities, 2:57370
Burszczyk, H., *See* Skowron, L.K., 2:55700
Burtis, C.A., *See* Mrochek, J.E., 2:57201
Burton, L., *See* Meakin, J.D., 2:56070
Burton, L.C., Studies related to Zn/sub x/Cd/sub 1-x/S solar cells. Technical report IEC/PV/TR/76/4, 2:56028 (CONF-761130—4)
Burwell, C.C., Siting studies for an asymptotic U.S. energy supply system based primarily on nuclear energy, 2:56361 (CONF-770441—2)
Buryachko, B.P., Determination of the effective depth of hot junction of surface thermocouples when investigating nonsteady heat transfer in an internal combustion engine, 2:57052
Busacker, G.P., The age and growth of the largemouth bass 'Micropterus salmoides' (lacepede), in a thermally loaded reservoir, 2:57441 (PB—264914)
Buschbach, T.C., Geologic perspectives of earthquake hazards in East-Central United States, 2:57467
Bush, M.A., *See* Munis, R.H., 2:57003
Bush, R.L., Dielectric screening in one-dimensional disordered systems, 2:57624
Busyrev, A.I., Effect of small geometric deviations of the shape of rotor blades of hydraulic turbines on their hydraulic qualities and cavitation erosion, 2:56005
Butterfield, C.E., Gas-cooled, graphite-moderated nuclear reactor, 2:56454
Buxmann, J., Influence of temperature stratification on the thermal performance of a dry cooling tower with natural draught, 2:56242
Buzek, B., *See* McConald, G., 2:56136
Bychkova, N.A., *See* Balezin, S.A., 2:56256
Byers, L., Monthly petroleum product price report, 2:55784 (PB—264142)
Monthly petroleum product price report, 2:55786 (PB—264460)
Bykovskii, YW.A., Three-dimensional structure of the spread of laser-produced plasma consisting of aluminium ions and nuclei, 2:57784
Byron, F.W. Jr., Glauber and Glauber-related methods in atomic physics, 2:57547
Bystritskii, D.B., *See* Trukhnii, A.D., 2:56302

C

Cafasso, F., New approach to assessing fusion plasma-materials interactions, 2:57789
Cafasso, F.A., *See* Fischer, A.K., 2:57497
Cagnetta, J.P., Spent fuel storage: utility perspective, 2:55891
Cajka, C.J., *See* Fraser, D.B., 2:56932
Caldarola, L., Fast reactor transfer functions with special reference to the nonlinearities and the spatial dependence of the heat transfer process, 2:56646
Callahan, G.D., Data input manual for RSI/TRANCO: a finite element heat conduction computer program, 2:57475 (Y/OWI/SUB—77/22303/1)
Thermo/viscoelastic analysis of the waste-container sleeve: I. Time-dependent salt loading on the sleeve and closure of the drillhole. Technical memorandum report RSI-0020, 2:55913 (ORNL/SUB—4269/4)
See Gnirk, P.F., 2:55908
Callahan, J.P., *See* Greenstreet, W.L., 2:55583
Calvo, R., *See* McCall, T.B., 2:56829
Cambillard, E., Tube tightness survey during Phenix steam generator operation, 2:56483 (CONF-760503—P1, pp 44-50)
Cambillard, M., *See* Benoist, E., 2:56487
Cameron, A.M., *See* Sigmund, P.M., 2:55815
Cameron, J.R., *See* Briggs, D.E., 2:55613
Campbell, C.S., Wear of rolling element bearings in sodium, 2:56497 (CONF-760503—P1, pp 160-166)
Campbell, J.H., Dynamics of oil generation and degradation during retorting of oil shale blocks and powders, 2:55836 (UCRL—79034)
Oil shale retorting. Part I. The effects of particle size and heating rate on oil evolution and intraparticle oil degradation, 2:55835 (UCRL—52256(Pt.1))
Campbell, J.W., *See* Ney, J.F., 2:55962
Campbell, R.B., Reactor considerations of ion beam-pellet fusion, 2:57780
Campolunghi, F., Design correlation for pressure drops in coiled, once-through steam generators, 2:56562
Campos, I.M., Specialization of SARA for software synthesis, 2:57819 (UCLA—34P214-37)
Candela, B.J., Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. The role of synthetic liquids from coal in meeting future energy demand. Final report, January 1975—December 1976, 2:55603 (FE—1752-14)
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-3. Availability of water for the development of a coal liquefaction industry. Final report, January 1975—December 1976, 2:55606 (FE—1752-18)
Cano, R., *See* Hosea, J., 2:57685
Canonico, D.A., Significance of reheat cracks to the integrity of pressure vessels for light-water reactors, 2:56367 (ORNL/NUREG—15)
See Greenstreet, W.L., 2:55583
Cantrell, E.L., *See* Bartsch, R.R., 2:57661
Capjack, C.E., *See* McMullin, J.N., 2:57631
Carbiener, W.A., Steam—water mixing and system hydrodynamics program. Task 4. Quarterly progress report, October—December 1976, 2:56767 (BMI-NUREG—1968)
Cardella, C., Numerical evaluation of thermodynamic equilibrium states for gas mixtures, 2:57245
Carelli, M.D., Optimized method for orificing LMFBR cores, 2:56530 (CONF-770611—6)
Carey, W.M., Acoustic analysis of TREAT LMFBR safety test R8, 2:56816
See Sheen, S.H., 2:56817
Carlson, D.E., Solar cells using discharge-produced amorphous silicon, 2:56046
See Pankove, J.I., 2:57178
Carlson, G.A., Material compatibility studies for PAHR incore molten pool experiments, 2:56838
Parametric design study of Tandem Mirror Fusion Reactors, 2:57707
Carlson, G.W., Measurement of the fission cross section of ^{241}Pu from 8 eV to 70 keV, 2:57605
Carlson, R.W., *See* Rehbein, D.A., 2:56875
Carmichael, D.C., *See* Blocher, J.M. Jr., 2:56033
Carmony, D.D., *See* Barish, S.J., 2:57564
Carr, J.A., *See* Carbiener, W.A., 2:56767
Carroll, T.O., Land use—energy simulation model: a computer-based model for exploring land use and energy relationships, 2:56915 (BNL—50634)
Carson, J.E., Atmospheric impacts of wet cooling systems for power plants, 2:56752
Carter, J.G., *See* Johnson, J.P., 2:57512
Carter, J.L., Vapor pressure equation-of-state in core disassmbly calculations, 2:56848
Carter, W.S., Use of getters in evacuated solar collectors, 2:56145
Cary, J.R., Ponderomotive force and linear susceptibility in Vlasov plasma, 2:57684
Casal, V., Development and testing of high-performance fuel pin simulators for boiling experiments in liquid metal flow, 2:56500 (CONF-760503—P1, pp 187-188)
Case, C.M., Constitutive relations for flow of water in the unsaturated zone, 2:57383 (NVO—1253-11)
Casey, A.W., Characterizing cinder rock with the scanning electron microscope, 2:55834 (UCID—17492)
Caspersson, S.A., *See* Kulwich, M.R., 2:56549
Cassapakis, C.G., *See* Rundquist, D.E., 2:57307
Casteels, F., *See* Tas, H., 2:56520
Castellani, F., Conduction of heat in a cylindrical homogeneous medium with a moving source, 2:55907
Castle, J.N., Heat transfer from a pool of molten UO_2 to a concrete slab, 2:56835
Castle, R.O., *See* Yerkes, R.F., 2:55794
Catton, I., *See* Castle, J.N., 2:56835
See Rhee, S.J., 2:56834
Caughey, D.A., *See* Jameson, A., 2:57251
Cavaleri, L., Forecast computation of maximum wave at Venice lagoon inlet entrances, 2:56218
Cech, B., Process for separating ceramics of uranium and plutonium from zirconium by hydriding and mixtures thereof, 2:55884

Cecil, C.B., *See* Meissner, C.R. Jr., 2:55547
Cedeno, M.H.C., Effect of silicon on the environmental cracking behavior of a high strength steel, 2:57114 (LBL—6012)
Centrell, J.S., Integrating solar energy concepts into chemistry/science curriculum, 2:56018
Cercy, J., *See* Fruchard, Y., 2:56580
Cha, Y.S., Bubble growth by expansion and dissolution in a variable pressure field, 2:56813
Chahroudi, D., Thermocrete heat storage materials: applications and performance specifications, 2:56167
Challenger, K.D., Steam generator materials engineering eleventh quarterly report, January—March 1977, 2:57112 (GEFR—14029-11)
See Spalaris, C.N., 2:56503
Chamberlain, O., *See* Auer, I.P., 2:57567
Chan, C.K., Alternative accident scenario for LMFBR core disruption, 2:56830
See Ferrell, W.L., 2:57744
See Okrent, D., 2:57761
See Reilly, J.T., 2:56845
Chan, J.K., Design study of cooling tower drift eliminators, 2:56240
Chan, S.H., Attenuation of radiological consequences from CDA's by radiation. Progress report, October 1, 1976—September 31, 1977, 2:56772 (COO—4040-1)
Effect of radiative cooling on HCDA radiological consequences during buoyancy period, 2:56822
Chan, W., Solar water preheater for use in a cold climate, 2:56114
Chance, M.S., Comparative numerical studies of ideal magnetohydrodynamic instabilities, 2:57663 (PPPL—1349)
Chang, A.L., Characterization and aging kinetics study of gamma prime strengthened Fe—Cr—Ni experimental alloys for breeder reactors, 2:57119 (WARD-AD—3045-5)
Chang, E.C., Systems approach to structural reliability assurance, 2:56670
Chang, J.Y., *See* Hoffman, N.J., 2:56498
Chang, R.K.C., *See* Neill, W.H., 2:57444
Chang, S.G., *See* Novakov, T., 2:57355
Chang, S.K., *See* Thie, J.A., 2:56595
Chang, Y.I., Impact of thermal near-breeders on uranium utilization, 2:56600
Relationships between nuclear growth rates and breeder doubling times, 2:56546
Chapman, D.S., *See* Pollack, H.N., 2:56206
Chapman, L.D., Physical protection of nuclear facilities. Quarterly progress report, January—March 1977, 2:55963 (SAND—77-0999)
Chappuis, J., *See* Martin, J.M., 2:55775
Charras, T., *See* Baylac, G., 2:56419
Chassay, R., *See* Reeves, F., 2:57093
Chater, A., *See* Macbeth, P.J., 2:55940
Chatterjee, C.N., Semi-coking coal resources of Raniganj coalfield, 2:55666
Chatzis, I., Modelling pore structure by 2-D and 3-D networks with application to sandstones, 2:57465
Chawla, J.M., *See* Kesper, B., 2:57304
Chawla, O.P., Evaluation of integral experiments and potential test facilities for future HTGR fission product safety research, 2:56775 (GA-A—14205)
Che, S.C., Properties of coal liquids produced by the Occidental flash pyrolysis process, 2:55618 (CONF-760885—, pp 40-58)
Chechel', N.S., *See* Busyrev, A.I., 2:56005
Chechetkin, Yu.V., *See* Krasnoyarov, N.V., 2:56481
Chell, G.G., Post-yield fracture mechanics theory and its application to pressure vessels, 2:56659
Chen, E., *See* Wentworth, W.E., 2:56152
Chen, E.C., *See* Siu, S.K., 2:55793
Chen, P.Y., Nonlinear characteristics of liquid sloshing in rigid tanks, 2:56872
Chen, S.S., Mathematical model for cross-flow-induced vibrations of tube rows, 2:57255
Chen, W.L., *See* Ishii, M., 2:56853
Chen, Y.S., Reflood simulation study of the FLECHT-SET system using RELAP4/MOD6, 2:56810
Cheng, A., *See* Lim, C.B., 2:57425
Cheo, B.R., *See* Kunhardt, E.E., 2:57678
Cheo, B.R.S., *See* Kunhardt, E.E., 2:57674
Chermanne, J., Gas-cooled breeder reactor making progress in Europe, 2:56551
Chern, J.M., Inelastic behavior of finite circular cylindrical shells, 2:56554
Cherniavsky, E.A., *See* Behling, D.J. Jr., 2:56954
Chernomordik, L.I., *See* Ol'khovskii, G.G., 2:56288
Chernov, S.A., *See* Aluker, E.D., 2:57187
Chernovets, A.K., *See* Usov, S.V., 2:56874
Chernyi, S.S., *See* Pis'man, B.Ya., 2:56681
Chernykh, V.V., *See* Vasil'chenko, G.S., 2:56330
Cherry, B.H., Outlook for uranium and enrichment supply in the United States, 2:55852
Cheung, L., Wave analysis of the tokamak drift mode, 2:57682
Chi, B.I., Biostratigraphy and taxonomy of devonian megaspores, arctic canada, 2:57466
Chiang, R.N.S., Solar energy system design approaches for architects, 2:56108
Chiang, S.H., *See* Cooper, M.H., 2:56516
Chiao, C.C., *See* Chiao, T.T., 2:57252
Chiao, T.T., Lifetimes of fiber composites under sustained tensile loading, 2:57252 (UCRL—78367)
Chien, S.H., Effect of solid fission products and dislocations on swelling and fission gas release in oxides during a fast overpower transient, 2:56800
Chikovani, V.V., *See* Grilikhes, V.A., 2:56084
Childs, W.J., Complete resolution of hyperfine structure in the close doublet λ5930.6 of ^{139}La by laser-atomic-beam spectroscopy, 2:57504
Chille, A., *See* Beretta, F., 2:57318
Chin, J., Structure of chemical vapor deposited silicon carbide, 2:57155
Chirkin, V.L., *See* Shelud'ko, L.P., 2:56271
Chisholm, R., Techniques of vibration analysis applied to gas turbines, 2:56293
Chistozvonov, D.B., *See* Azaev, G.A., 2:55995
Cho, D., *See* Chan, S.H., 2:56822
Choi, C., Application of a unified slowing-down theory to fusion plasmas, 2:57648
See Miley, G.H., 2:57767
Choi, D., *See* Horton, W. Jr., 2:57665
Choppin, G.R., *See* Baisden, P.A., 2:57229
Chopra, K.L., *See* Das, S.R., 2:56051
Chopra, P.S., *See* Srinivas, S., 2:56501
See Wolz, G.C., 2:56502
Chou, T.S., Cryopumping of deuterium hydrogen and helium mixtures on smooth 4.2 K surfaces, 2:57785 (BNL—22759)
Chovet, P., Cooling system intended for cryogenerators, 2:57271
Choyke, W.J., Momentum transfer and damage energy gradient effects on helium permeability, 2:57148
See Spitznagel, J.A., 2:57149
Christenson, J.M., Development of the undergraduate nuclear engineering co-op program at Cincinnati, 2:56628
Christiansen, B., Coal development information packet. Supplement 1, 2:55655 (NP—22076)
Christianson, C.C., Batteries for mail vans, 2:56908
Christophorou, L.G., *See* Johnson, J.P., 2:57512
Chrusciel, Z., Reflecting power of vitrinites of Polish coals and its correlation with indices of coal class, 2:55646
Chu, T.L., Polycrystalline silicon solar cells on metallurgical silicon substrates, 2:56057
Chubarov, V.A., *See* Bavel'skii, D.M., 2:56314
Chubb, T.A., *See* Nemecek, J.J., 2:56157
Chudnovskii, F.A., *See* Gavrilyuk, A.I., 2:57161
Chulos, L.E., Improved method for operating sodium system cold traps, 2:56543
Operational techniques employed for the liquid sodium source term control loops, 2:56491 (CONF-760503—P1, pp 116-121)
Chun, J., Failure probability of the battery system following loss of ac power, 2:56862
On the probability of loss of dc power following ac failure in a nuclear power plant, 2:56791 (PB—265099)
Chung, D., *See* Bauerle, G., 2:56163
Chung, P.M., High temperature coal and slurry combustor according to a one-dimensional flow model, 2:55722 (CONF-770530—2)
Chupis, N.E., *See* Terdovidov, A.S., 2:55754
Church, D.A., Electronic state alignment, orientation, and coherence produced by beam-foil collisions, 2:57499
Cias, Z., Determination of the optimum depression in methane-drainage boreholes in mines, 2:55696
Ciszek, T.F., *See* Schwuttke, G.H., 2:56031
Claffey, P.J., Passenger car fuel conservation. Final report, 2:57030 (PB—265369)
Clark, P.M., *See* Rubinstein, H.J., 2:55892
Clark, R.H., *See* Olszewski, J.S., 2:56412
Clausmeyer, H., Manufacture of heavy reactor components with particular consideration to quality assurance, 2:56678
Claxton, K.T., Solubility of oxygen in liquid sodium: effect on interpretation of corrosion data, 2:56527 (CONF-760503—P1, pp 407-417)
Cleaver, J.E., *See* Slor, H., 2:57433
Cleland, J.W., *See* Wood, R.F., 2:56029
Clement, C.F., Corrosion of steels in liquid sodium, 2:56525 (CONF-760503—P1, pp 393-399)
Clement, G., *See* Baylac, G., 2:56419
Clifford, P., *See* Bliss, C., 2:56923
Clikeman, F.M., Role of nuclear laboratory courses at Purdue University, 2:56616
Closmann, P.J., Producing shale oil by flowing hot aqueous fluid along vertically varied paths within leached oil shale, 2:55840
Clump, C.W., Chemical characterization, handling, and refining of SRC to liquid fuels. Final report on Task 3: handling characteristics of SRC, 2:55712 (FE—2003-18a)
Caadt, P.A., *See* Han, J.T., 2:56818
Coburn, T.T., *See* Campbell, J.H., 2:55835, 2:55836
Cochran, F.L., *See* Allen, A.W., 2:57671
Cochran, N.P., ERDA demonstration plant program for high-Btu gas, 2:55594
Cochrane, D.A. Jr., Offshore environmental monitoring program for a proposed nuclear power plant in Islote, Puerto Rico: operations and planning, 2:56753

Cochrane, M.W., *See* Joyce, M.E., 2:57047
Coen-Porisini, F., High temperature corrosion in the thermochemical hydrogen production from nuclear heat, 2:55975
Coffou, E., *See* Knapp, V., 2:56171
Cogliati, A., Experimental 3000 v d.c. locomotive of the Italian state railways with chopper control, 2:57027
Cohen, J.J., Determination of performance criteria for high-level solidified nuclear waste, 2:55896 (NUREG—0279)
See Tonnessen, K.A., 2:55952
Cohen, M.O., *See* Steinberg, H.A., 2:56806
Cohen, S.A., *See* Dylla, H.F., 2:57801
Cohn, D.R., Detailed design features of a high-field compact tokamak reactor (HFCTR), 2:57716
Cohn, S., Household fuel demand analysis, 2:57013 (CONF-770225—1)
Cole, C.R., *See* Arnett, R.C., 2:57397
Cole, J.F., ILZRO health studies, 2:56895
Coleman, D.R., *See* Dearien, J.A., 2:56369
Coleman, G., *See* Mitchell, R.C., 2:56156
Coleman, H.J., *See* Hirsch, D.E., 2:57206
Coleman, L.W., Ultrafast x-ray diagnostics for laser fusion experiments, 2:57644
Collings, E.W., *See* Gelles, S.H., 2:57092
Collins, D.S., Coal gasification valves. Phase I. Component development test procedure, 2:55575 (FE—2355-12(Rev.A))
Coal gasification valves. Phase I. Type III valve prototype test plan, 2:55577 (FE—2355-14)
Collins, G.J., *See* de Hoog, F.J., 2:57287
Colombo, P., *See* Neilson, R.M. Jr., 2:55905
Colome, J., *See* Fruchard, Y., 2:56580
Colsher, C.S., *See* Robison, W.L., 2:57437
Coltman, R.R. Jr., *See* Kerchner, H.R., 2:57141
Colvert, D., *See* DiCanio, D.G., 2:55732, 2:55733, 2:55734
Colville, S., *See* Chan, W., 2:56114
Comon, J., A-508 class 3 forgings for pressure vessels, 2:56420
Condon, J.B., *See* Jackson, R.L., 2:57242
Conn, R.W., Minimizing long-term radioactivity in fusion reactors by isotopic tailoring, 2:57791
See Abdel-Khalik, S.I., 2:57781
See Lue, J.W., 2:57739
See Wolfer, W.G., 2:57795
Conner, W.D., Tertiary oil recovery by CO_2 injection. Quarterly report, October—December 1976, 2:55755 (FE—5302-5)
Connor, B., *See* Byers, L., 2:55784, 2:55786
Conrads, L.A., *See* Asman, W.A.H., 2:57350
Conti, E.F., Radiological criteria for release of land and for decommissioning facilities, 2:56588
Cook, D., *See* Cohn, D.R., 2:57716
Cook, G.E., *See* Molz, F.J., 2:56166
Cook, T.R., Studies on the fatigue of branched connections related to the shakedown pressure, 2:57258
Cook, W.A., INGEN: a general purpose mesh generator for finite element codes, 2:57812 (LA-UR—77-1345)
Cool, W.S., *See* Nussbaumer, D.A., 2:57430
Cooper, C.L., *See* Whittle, C.E., 2:56741
Cooper, M.H., Proceedings of the international conference on liquid metal technology in energy production, 2:56477 (CONF-760503—P1)
Proceedings of the international conference on liquid metal technology in energy production, 2:56529 (CONF-760503—P2)
Radiochemical measurement of mass transport in sodium, 2:56516 (CONF-760503—P1, pp 304-312)
Coote, D.R., Modern mobile radio system, 2:55826
Coplen, T.B., *See* McMurtry, G.M., 2:56189
Corkum, P.B., *See* Burnett, N.H., 2:57683
Corradini, M., Proposed model for vapor bubble-slug heat transfer during LMFBR HCDAs, 2:56846
Cort, G.E., *See* Krakowski, R.A., 2:57719
Costantino, M.S., Empirical relation for dilatant behavior in brittle rocks, 2:57474 (UCRL—79011)
Cottrell, W.B., Operating U.S. power reactors, 2:56382
Coty, U., Wind energy mission analysis. Executive summary, 2:56219 (TID—27698)
Counts, J., *See* Sisler, J.A., 2:55888
Coustau, H., Example of statistical data available for petroleum exploration: the STATSID file, 2:55745
Cowan, A.M., *See* Bender, F.E., 2:56092
Cowgill, M.G., *See* Johnson, R.N., 2:56492
Cox, A.N., *See* Sandford, M.T. II, 2:57478
Cox, J.L., Homogeneous catalytic hydrogenations of complex carbonaceous substrates, 2:55555 (BNWL-SA—6055)
Cox, N.D., Energy oriented study of fluidized bed systems, 2:57036 (TREE—1135)
Cox, S., *See* Dias, M.S., 2:56022
Craig, A.G. Jr., *See* Bonewitz, R.A., 2:56144
See Powers, J.H., 2:56139
Craighead, H.G., Optical properties of selectively absorbing Ni/Al_2O_3 composite films, 2:57168
Crall, G.C.P., *See* Cuba, J.F., 2:57004
Crane, D.P., Electric mail delivery vans, 2:57068
Cranstone, D.A., *See* McIntosh, J.A., 2:56933
Cravens, M.N., Safeguards system design methodology, 2:55961 (SAND—77-0890C)
Crawford, J.H., *See* Frye, J.C., 2:55919
Creed, K.E., Polyurethane elastomer system, 2:57170 (GEPP—305)
Cremer, J., OPEC and the monopoly price of world oil (World Oil Project). Working paper, 2:56970 (PB—265015)
Crespi, H.L., *See* Katz, J.J., 2:57438
Criado, A., *See* Martinez, J., 2:56056
Criscuolo, A.L., Coulometer operator's manual, 2:57194 (LA—6883-MS)
Crissman, H.A., Flow microfluorometric and spectrophotofluorometric analysis of DNA staining in mammalian cells, 2:57416 (LA-UR—77-365)
Croff, A.G., Report of the workshop on the technological implications of burning actinides to the fuel cycle, 2:55898 (CONF-770354—1)
Cronauer, D.C., Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels. Quarterly report, December 1976—February 1977, 2:55609 (FE—1800-12)
Cronenberg, A.W., *See* Gunnerson, F.S., 2:56857
Crossland, B., Explosive plugging of nuclear heat exchangers, 2:56679
Crouch, W.B., *See* Slater, W.L., 2:55988, 2:55989, 2:55990
Crowley, C.J., *See* Block, J.A., 2:56773
Crutchmer, J.A., TATB formulation study. Final report, 2:57347 (MHSMP—77-20)
Cuba, J.F., Bibliography on available computer programs in the general area of heating, refrigerating, air conditioning and ventilating. Research project, 2:57004 (PB—264904)
Cudnik, R.A., *See* Carbiener, W.A., 2:56767
Cuenod, M., *See* Jaffe, F., 2:56174
Culotta, S., Unsteady expansions in homogeneous gas-liquid two-phase mixtures, 2:57299
Cummings, G.E., Risk assessment to determine the advisability of seismic trip systems, 2:56863
Cumo, M., On two-phase thermal boundary layer along heated walls, 2:56395
See Campolunghi, F., 2:56562
Cunningham, H.W. Jr., Adenosine triphosphate concentration in relation to microbial biomass in aquatic systems, 2:57389 (COO—1599-120)
Cunningham, L.J., *See* Nussbaumer, D.A., 2:57430
Currie, R.L., *See* Mayo, C.W., 2:56363
Curtis, H., *See* McConald, G., 2:56136
See McDonald, G., 2:56137
Curtis, H.B., *See* Weinberg, I., 2:56043
Curzio, G., *See* Castellani, F., 2:55907
Cutrone, M.B., High temperature gas turbine engine component materials testing program. Task 1. Quarterly technical progress report No. 7, January 1—March 31, 1977, 2:56250 (FE—1765-30)
Czirr, J.B., *See* Carlson, G.W., 2:57605

D

D'Alessandro, M., *See* Girardi, F., 2:55951
D'Alessio, A., *See* Beretta, F., 2:57318
D'yachenko, N.Kh., Investigation of the three-dimensional thermal and stress strained state of a one-piece piston of the chn 21/21 diesel engine, using the finite element method, 2:57324
D'yakonov, A.I., Predicting oil and gas potential from tectonic conditions of distribution of oil and gas fields in west Pre-caucasus, 2:55743
D'yakonov, R.I., Investigation of the axial force in the turbine section with a bleeding chamber, 2:56300
Dach, K., Neutron noise analysis as a diagnostic method of mechanical vibrations in WWER type reactor core components, 2:56425
Dafter, R., Pipeline system for more natural gas from the North Sea, 2:55820
Dahl, L.K., *See* Ohanian, E.V., 2:57427
Dahlbacka, G.H., *See* Pearlman, J.S., 2:57651
Dahlke, L.W., *See* Saxton, H.J., 2:57208
Dahlman, R.C., *See* Pechin, W.H., 2:55936
Dal'yan, I.B., Geothermal conditions of subsalt rocks of the eastern part of pre-caspian depression and their oil and gas potential, 2:55751
Dalessandro, J.A., Advantages of nonuniform current density distribution in an ohmic heating coil, 2:57736
Danescu, Al., *See* Marinescu, M., 2:55980
Daney, D.E., *See* Jones, M.C., 2:56360
Daniels, E.J., *See* Anderson, P.J., 2:55814
Danilejko, M.V., Power resonances of a two-mode ring laser, 2:57290
Darcemont, M., Study of a method of accelerated hardening of concrete by microwaves, 2:57165 (ORNL-tr—4356)
Darlaston, B.J.L., *See* Harrison, R.P., 2:56675
Darr, D.G., Anticipated chemical emissions from a large fuel reprocessing plant, 2:55937
Darvishian, A., Higher efficiency wind motor with receptors of diminished drag characteristics, 2:56225
Das, S.K., *See* Behrisch, R., 2:57494
See Kaminsky, M.S., 2:57803

Das, S.R., Fabrication of thin film Cu_2S/CdS solar cells by a novel evaporation technique, 2:56051
Das Gupta, N.N., *See* Biswas, S.C., 2:55549
Datz, S., Atomic collisions and fission technology, 2:57621
Dau, G., Secure storage of radioactive waste, 2:55897
Davidson, E.R., *See* Bender, C.F., 2:57554
Davidson, J.W., *See* Parish, T.A., 2:57796
Davidson, K.V., *See* Hollabaugh, C.M., 2:57164
Davidson, R., Influence of strong inhomogeneities on high-frequency mirror-drift-cone and convective-loss-cone instabilities, 2:57667
Davies, T.J., *See* Franks, L.A., 2:57309
Davis, A., Petrographic composition of coals: its importance in liquefaction processes, 2:55595 (CONF-760885—, pp 14-33)
Davis, D.E., Apparatus for mixing particulate substances using a fluid under pressure, 2:56713
Davis, J., *See* Dias, M.S., 2:56022
Davis, J.R., *See* Hopkins, R.H., 2:56032
Davis, J.W., Monitoring sinusoidal vibration environments with a television system, 2:57314 (BDX—613-1295(Rev.))
Davis, L.R., *See* Shirazi, M.A., 2:57386
Davis, S.L., Energy loss rates of energetic ions injected into the FM-1 spherator, 2:57632
Davis, S.N., *See* Frye, J.C., 2:55919
Davis, W., *See* Byers, L., 2:55784, 2:55786
Davison, R.R., Reinforced pillow solar water heater, 2:56116
Dawson, T.H., Scaling of fixed off-shore structures, 2:57330
Day, D.E., *See* Rahman, S.F., 2:55565
Day, R.A., *See* Spalaris, C.N., 2:56503
De Angelis, R.J., *See* Reucroft, P.J., 2:55574
de Carmoy, G., Energy policies of France Great Britain, and Germany compared, 2:56959
de Heer, F.J., Elastic and total scattering of electrons by noble gases, 2:57519
de Hoog, F.J., Discharge studies of the Ne-Cu laser, 2:57287
de Saussure, G., *See* Difilippo, F.C., 2:57606
de Vault, A.N., *See* Pitchford, A.C., 2:55768
De Windt, P., *See* Reynen, J., 2:56383
de Winter, F., Financial incentives for the fabrication of improved absorption coatings for the flat plate collector, 2:56142
de Winton, C., North Thames shuts down last gas-making station, 2:55991
Dean, E., Report from Berkeley, 2:56946
Dearien, J.A., FRAP-S2: a computer code for the steady state analysis of oxide fuel rods, 2:56369 (TREE-NUREG—1107)
Deese, D.A., Political and legal implications of radioactive waste disposal at sea, 2:55931
DeGroot, J.S., *See* Hobbs, W.E. Jr., 2:57675
Degtyarev, V.F., *See* Belokurova, I.N., 2:57152
Dehmelt, H.G., Ion-storage collision technique, 2:57500
Del, D.A., Computation of specific thermonuclear reaction rates: the STEEP Code, 2:57754
Deju, R.A., *See* Arnett, R.C., 2:57397
Delfin, B., *See* Bencic, B., 2:55770
Delyagin, G.N., Mathematical model to study the process of combustion of a stream of atomized liquid fuel as a control object, 2:57322
Demkov, Yu.N., Asymptotically exact theory of electron exchange in distant collisions, 2:57650
Demyashkin, N.M., *See* Balinov, I.M., 2:55670
Denisenko, V.A., *See* Titushkin, V.A., 2:55844
Denisov, G.N., Mechanism of the decomposition of ammonia on nickel films at temperatures below and above the Curie point, 2:55997
Denning, R.S., *See* Carbiener, W.A., 2:56767
Dennis, C., *See* Abdou, M.A., 2:57705
Deonigi, D.E., Energy supply system modeling, 2:57701
DePorter, E.L., Determination of optimal composition of nondeliverable fabrication plant fuel material, 2:55873
Depp, S.W., *See* Bobbett, R.E., 2:57340
Der Manuel, G., Design and fabrication considerations for CRBRP ex-vessel storage tank (EVST), 2:56545
Derevshchikov, A.A., *See* Akopin, V.D., 2:57569
Derkach, L.M., *See* Gonchar, V.Y., 2:57615
deRosset, A.J., Characterization of coal liquids. Intermediate report for the period July—December 1975. Upgrading solvent refined coal process filter feed, 2:55624 (FE—2010-01)
Derrick, M., *See* Barish, S.J., 2:57564
Deurbrouck, A.W., *See* Warnke, W.E., 2:55554
Deutscher, S.B., *See* Alire, R.M., 2:57765
DeVan, J.H., Compatibility of structural materials with boiling potassium, 2:56528 (CONF-760503—P1, pp 418-426)
See Strain, J.E., 2:57193
Devaney, J., Preliminary assessment of potential accidents of laser fusion electric generation stations, 2:57764
Devaney, W., *See* Burton, L.C., 2:56028
See Meakin, J.D., 2:56070
DeVries, A.L., *See* Qvist, J., 2:57442
DeWitt, R., Isotopically tailored materials for fission and fusion reactors, 2:56652 (MLM—2426(OP))
Survey of large-scale isotope applications: nuclear technology field, 2:55969 (MLM—2391)
Dhir, V.K., *See* Castle, J.N., 2:56835
See Rhee, S.J., 2:56834
di Lauro, G.F., *See* Kulwich, M.R., 2:56549
Di Pasquantonio, F., *See* Barbucci, P., 2:56642
Dias, M.S., Comparison of a thermopile broadband detector and a photon detector for the measurement of solar radiation. Part I. Analysis of simultaneous data. Part II. Cosine response functions, 2:56022 (PB—265282)
Diaz, N.J., Process instrumentation measurements for nuclear engineering laboratories, 2:56615
DiCanio, D.G., Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume I. Development and application of cost model. Final report, 2:55732 (PB—264438)
Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume II. Program user manual. Final report, 2:55733 (PB—264439)
Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume III. Supporting data. Final report, 2:55734 (PB—264440)
Dickey, B.R., *See* Slansky, C.M., 2:55900
Didenko, L.A., *See* Angelov, N., 2:57570, 2:57571
Dierckx, R., Neutron dosimetry at the intense neutron source (INS), 2:57788 (LA-UR—77-1033)
Dietrich, W., Diesel engines having advantageous emission characteristics for mining plants, 2:57085
Dietz, W., Material effects in LMFBR sodium systems, 2:56517 (CONF-760503—P1, pp 313-323)
Difilippo, F.C., Measurement of the ^{238}U subthreshold fission cross section for incident neutron energies between 0.6 and 100 keV, 2:57606
Dikareva, R.P., Calculation of the parameters of a radiant flux receiver, taking into account its exchange with the environment, 2:56024
Dillon, R.W., *See* Bender, F.E., 2:56092
Dimentberg, M., Transportation of liquids, 2:55819
Dimitriades, B., Oxidant control strategies. Part I. Urban oxidant control strategy derived from existing smog chamber data, 2:57365
Dinkelacker, A., Flow of radioactive gases through ground layers, 2:56750 (IKE—6-104)
DiStefano, J.R., Compatibility of bismuth and bismuth—lithium solutions with refractory metals and graphite, 2:57108 (CONF-760503—P2, pp 462-469)
Dixit, K.B., Finite element analysis of reactor support diaphragm for elastic instability, 2:56465
Dixon, K., *See* Gerard, A., 2:57360
DiZio, S.F., Initial production of CdS photovoltaic products, 2:56069
Dizon, A.E., *See* Neill, W.H., 2:57444
Dobratz, B.M., *See* Kury, J.W., 2:57349
Dobretsov, Y.P., *See* Abramov, V.V., 2:57565
Doctor, P.G., Ratio estimation techniques in the analysis of environmental radionuclide data, 2:57379 (BNWL-SA—5975(Rev.))
Dodd, P.H., ERDA's National Aerial Radiometric and Magnetic Survey, 2:57385
Dodge, J.B., *See* Brau, C., 2:57496
Doerling, R., Liner design and construction for the thorium-cooled high-temperature reactor and the safety containment at the Gundremmingen-2 nuclear power plant, 2:56375
Doerner, R.C., *See* Pekarsky, M.I., 2:56815
Doetschmann, K., THECA: a code system for 3-D thermohydraulic layout of fast reactors, 2:56537 (EURFNR—1437)
Dolan, C.A., Uranium accountability for ATR fuel fabrication. Part I. A description of the existing system, 2:55965 (TREE—1145)
Dolbear, G.E., *See* Che, S.C., 2:55618
Dolgina, V.D., *See* Aminov, R.Z., 2:57008
Dolgoplosk, E.B., *See* Zhukovakii, G.V., 2:56317
Dolgoshein, B.A., *See* Abramov, V.V., 2:57565
Dolinin, V.N., *See* Sergeev, A.I., 2:57064
Dombeck, T., *See* Barish, S.J., 2:57564
Domes, J., *See* Bencic, B., 2:55770
Donahue, W.H., *See* Nicol, J.A.C., 2:57448
Donath, F.A., *See* Frye, J.C., 2:55919
Donelson, S., *See* Siri, W.E., 2:55957
Dong, R.G., Comparing structural loads in large pools evaluated with the LUSH code and current design methods, 2:56796 (UCRL—79277)
Donichkin, A.G., X rays from fragments in fission of ^{235}U by 3.5-MeV neutrons, 2:57609
Doody, T.J., Versatile multiple outlet semi-ball and socket valve, 2:57250 (CONF-770634—1)
Dooley, J.E., *See* Hirsch, D.E., 2:57206
See Thompson, C.J., 2:55641

Dorfman, L.A., Quasithreedimensional calculation of flow in turbine stages, 2:56327
Dorozhko, E.V., Optical absorption of vanadium pentoxide in the energy range 1.0—5.5 eV, 2:57159
Optical absorption of VO_2 and V_2O_3 films and ability to predict semiconductor—semimetal phase transitions in transition metal compounds, 2:57160
Dorrence, S.M., Status of tar sands conversion process technology and residuals management, 2:55833 (CONF-7605160—1)
Dosaj, V.D., *See* Hunt, L.P., 2:56041
Dostal, K.A., *See* Joyce, M.E., 2:57047
Douglass, C.H., *See* McClure, D.J., 2:57514
Dowd, J.P., *See* Stein, N.A., 2:57566
Downes, E.J., Ranging-arm shearer: its introduction in the Barnsley seam at Frickley Colliery, 2:55686
Draggan, S., Effects of substrate type and arsenic dosage level on arsenic behavior in grassland microcosms. Part I. Preliminary results on ^{74}As transport, 2:57380 (CONF-770647—1)
Drago, N.P., *See* Huff, J.E., 2:57445
Dreesen, D.R., *See* Purtymun, W.D., 2:55935
Dreizin, L.Z., *See* Balashov, N.A., 2:56994
Dresher, M., *See* Siri, W.E., 2:55956
Driemeyer, D., *See* Miley, G.H., 2:57711
Drinkard, G., Hydrothermally forming a flow barrier in a leached subterranean oil shale formation, 2:55839
Drobnik, S., Method of preparation for storage of liquids used in the reprocessing of spent nuclear fissile and/or fertile materials, 2:55885
Droher, J.J., *See* Hoffman, N.J., 2:56498
See Whitlow, G.A., 2:56494
Drokonov, A.M., *See* D'yakonov, R.I., 2:56300
Dronov, Y.D., *See* Kaminskii, L.V., 2:55720
Drukarev, G., Multiple scattering approach to the vibrational excitation of molecules by slow electrons, 2:57529
Dubis, D., *See* Lewis, R., 2:55563
Dubois, P.F., Operator splitting on vector processors, 2:57825 (UCRL—79316(Rev.1))
Dubov, V.N., *See* Livshits, M.A., 2:56294
Dubovskii, I.E., Improvement of cleaning of boiler heating surfaces by steam blowing devices, 2:56307
Dubrovina, S.M., *See* Gokhberg, B.M., 2:57608
Dubrovskii, L.A., *See* Zakhidov, R.A., 2:56124
Dubsek, F., Research, development and realization of sectional modular sodium heated steam generator, 2:56566
Duco, J., *See* Fruchard, Y., 2:56580
Duerrwaechter, E., *See* Berndt, M., 2:55809
Duffey, D., Coal composition by ^{252}Cf neutrons and flux level corrections, 2:57192
Duke, J.M., Qualification of Alloy 800 for sodium heated steam generators, 2:56505 (CONF-760503—P1, pp 211-217)
Dullien, F.A.L., *See* Chatzis, I., 2:57465
Dumnov, V.P., *See* Livshits, M.A., 2:56294
Dumont, R.S., *See* Chan, W., 2:56114
Duncan, H.C., *See* McCown, J.J., 2:56489
Dunduru, J., *See* Weertman, J., 2:56204
Dunn, J.T., *See* Jackman, A.H., 2:56470
Dunning, T.H. Jr, *See* Hay, P.J., 2:57503
Dunskii, V.D., Contamination of heating surfaces of boilers at Tyumen heat and power plant burning local peat, 2:56295
Dupree, S.A., *See* Pope, R.B., 2:57280
Durand, J., Magnetic regimes in amorphous Ni—Fe—P—B alloys, 2:57126 (CALT—822-88)
See Amamou, A., 2:57101
Durran, D., *See* Liu, M., 2:57357
Durup, J., Laser photodissociation of hydrogen molecule ions with fragment kinetic energy analysis, 2:57506
Dutina, D., *See* Spalaris, C.N., 2:56503
Duverger de Cuy, G., *See* Fruchard, Y., 2:56580
Duzniak, S., Basaltic intrusion and its influence on coal in Seam 507 at Sosnica Colliery, 2:55663
Dwiwanto, S.A., Agglomerated brown coal fine coke as a sintering fuel, 2:55644 (NP—22126)
Dyablo, V.V., *See* Tetel'baum, S.D., 2:56563
Dyer, F.F., Study of radionuclides in the Peach Bottom HTGR primary circuit, 2:56436
See Wichner, R.P., 2:56435
Dyer, P., Angular-momentum transfer in deeply inelastic scattering of 610-MeV ^{86}Kr by ^{209}Bi, 2:57599
Dylla, H.F., First-wall characterization of tokamaks by in situ auger electron spectroscopy, 2:57801
Dyshkant, A.S., *See* Abramov, V.V., 2:57565
Dyslin, D.A., *See* Holmes, J.M., 2:55558
Dzhigit, G.A., Investigation of gas turbine plant control systems with two controllers acting on one actuator, 2:56338
Dzhmukhadze, S.V., *See* Angelov, N., 2:57570, 2:57571
Dzhuraev, T.D., *See* Norov, E.Zh., 2:56118

E

Eacott, K.B., Advances in small zero-leak valves point to better nuclear power-plant reliability, 2:56657
Easley, P.G., *See* Nelson, R.W., 2:57375
Eastman, M.P., *See* London, R.E., 2:57232
Eaton, A.D., *See* Gross, M.G., 2:57391
Eberhardt, M.K., Radiation-induced homolytic aromatic substitution. VI. The effect of metal ions on the hydroxylation of benzonitrile, anisole, and fluorobenzene, 2:57236
Eberhart, J.G., Final report on Test L4, a loss-of-flow experiment, 2:56766 (ANL—76-130)
Eckard, R., *See* Allison, T., 2:57816
Eckardt, R.C., *See* Lehmberg, R.H., 2:57768
Eckart, L.E., Interdisciplinary graduate program to prepare science majors for careers in Radiation Health Physics, 2:57462
Edelberg, J., *See* Hu, C., 2:56049
Edelstein, R.M., *See* Stein, N.A., 2:57566
Eder, E., Remote monitoring system for nuclear reactors, 2:56751
Eder, L., *See* Bayler, T., 2:57053
Edie, D.D., Immiscible fluid: heat of fusion energy storage system, 2:56168
Edling, D.A., *See* Griffin, J.F. Peterson, J.B., 2:57277
Edmonds, A., *See* Flynn, L., 2:57024
Edwards, A.K., Collisionally produced autoionizing and autodetaching states of neutral atoms and their negative ions, 2:57510
Edwards, C.L., *See* Reiter, M., 2:56177, 2:56182
Edwards, D.K., *See* Reilly, J.T., 2:56845
Edwards, L.L., *See* Bowman, B.R., 2:56795
Edwards, M.S., *See* Holmes, J.M., 2:55558
See Salmon, R., 2:55615, 2:55616
Efendiev, T.S., *See* Zaporozhchenko, V.A., 2:57291
Effertz, P.H., *See* Hagn, L., 2:56692
Efimenko, G.P., Permissible value of compensation stresses in piping systems of power plants, operating in creep conditions, 2:56289
Efimov, Y.V., *See* Savitskii, E.M., 2:57096
Efros, E.I., *See* Shapiro, G.A., 2:56304
Eggers, G., *See* Russell, J.L. Jr., 2:56079, 2:56088
Egorov, N.P., *See* Volchenok, V.I., 2:57295
Ehrenspeck, H., *See* Melvin, P., 2:55792
Ehrhardt, H., *See* Paul, D., 2:57527
Ehst, D., Impact of key plasma parameters on tokamak reactor designs, 2:57717
Eibl, K., Nonstationary gas network calculation: simulation and comparative measurement, 2:55822
Eibling, J.A., *See* Hall, E.H., 2:56094
Eickelpasch, N., Experimental evaluation of the fast neutron fluence for the KRB reactor pressure vessel and its operational relevance, 2:56381
Eidinger, A., Design, application and testing of SF_6 insulated cable, 2:56359
Eismont, V.P., *See* Donichkin, A.G., 2:57609
Ekimova, M.M., *See* Kuchumova, E.O., 2:56280
Eklund, S., IAEA experience in the transfer of nuclear technology, 2:56631
Ekpanyaskun, S., *See* Mcdermott, P., 2:56888
El-Gazzar, A.M., *See* El-Ghonemy, A.A., 2:57377
El-Genk, M., Assessment of molten fuel motion in the CRBR shield plug following a core disruptive accident, 2:56850
El-Ghonemy, A.A., Mineral element composition of the natural vegetation along a transect at Mareotis, Egypt, 2:57377
Elias, E., *See* Gozani, T., 2:57191
See Verbinski, V.V., 2:55714
Elie, X., *See* Abramson, R., 2:56484
Elkins, R.H., *See* Macriss, R.A., 2:57459
Elle, D.R., *See* Burson, Z.G., 2:57370
Elleman, T.S., *See* Stam, E., 2:56625
Ellie, G., Foreseeable developments of mining techniques in large coal-producing countries, 2:55687
Ellington, E.E., *See* Manthos, G.J., 2:55570
Ellis, M.J., *See* Harris, G.S., 2:56955
Ellis, W.H., *See* Selvatici, E., 2:57144
Elstner, M., *See* Kuehn, R., 2:55627
Embry, A., Middle--upper Devonian clastic wedge of the Franklinian geosyncline, 2:55750
Emendoerfer, D., Nuclear power plants 1976 - international VGB congress at Stuttgart, September 7 to 10, 1976, 2:56366
Emerson, R.R., *See* Harrison, F.L., 2:57446
Emery, A.F., Fracture in straight pipes under large deflection conditions. I. Structural deformations, 2:56661
See Kobayashi, A.S., 2:56658, 2:56672
See Love, W.J., 2:56374
Emrich, W., *See* Russell, J.L. Jr., 2:56079, 2:56088
England, T.R., *See* Stamatelatos, M.G., 2:57618
England, W.B., *See* Wahl, A.C., 2:57501
Enright, G.D., *See* Burnett, N.H., 2:57683
Epting, J.T., *See* Noble, J.B., 2:56582
Erdman, C.A., *See* Kennedy, M.F., 2:56821
Erdmann, C.A., *See* Garner, P.L., 2:56851
Erdmann, R.C., Preliminary accident radiological risk assessment of a large commercial MOX fuel fabrication plant, 2:55945
Eremenko, N.A., *See* Maksimov, S.P., 2:55742
Eremina, V.P., *See* Trusov, L.P., 2:56255
Erickson, P.B., *See* Conti, E.F., 2:56588
Eriksson, K., Bridge control of marine diesel propulsion machinery, 2:57056
Ervin, G., *See* Bauerle, G., 2:56163

Esaibegyan, S.V., Polarization phenomena in isobar production by a weak neutral current, 2:57577
Escher, W.J.D., Preliminary systems-engineering study of an advanced nuclear-electrolytic hydrogen-production facility, 2:56430 (NP—22192)
Espitalie, J., Rapid method for source rock characterization and for determination of their petroleum potential and degree of evolution, 2:55746
Essenhigh, R.H., *See* Austin, L.G., 2:55642
Estabrook, L.E., *See* Slater, W.L., 2:55988, 2:55989, 2:55990
Estes, R., *See* Horton, W. Jr., 2:57665
Estrin, G., *See* Campos, I.M., 2:57819
See Razouk, R.R., 2:57821
Etinberg, M.I., *See* Bavel'skii, D.M., 2:56314
Eustis, R.H., High magnetic field MHD generator program. Quarterly report, October—December 1976, 2:56996 (FE—2341-1)
Evans, A.D., Operation of PFR and influence upon the design of CFR I, 2:56541 (TRG-Report—2819(D))
Evans, D.L., Terrestrial concentrating photovoltaic power system studies, 2:56068
Evans, V.A., Recent state laws regulating power facility siting, 2:56748
Evenko, V.I., Characteristics of the working cycle of a turbopiston internal combustion engine, 2:57060
Evgen'ev, V.Yu., *See* Dorfman, L.A., 2:56327
Evseev, V.S., *See* Grilikhes, V.A., 2:56084
Evseeva, S.A., *See* Delyagin, G.N., 2:57322
Evtifeev, V.I., *See* Andreev, V.A., 2:57042
Ewald, J., *See* Kussmaul, K., 2:56386
Ewest, E., Calculations of radioactivity release due to leaching of vitrified high-level waste, 2:55922
Eyre, B.L., *See* Bullough, R., 2:57143
Ezra, D., Good prospects for coal in Great Britain, 2:55740

F

Faddeev, I.P., *See* Kirillov, I.I., 2:56272
Fadeev, N.G., *See* Angelov, N., 2:57570, 2:57571
Fader, G.B., *See* Kessler, T.C., 2:56798
Faierman, I.P., Organization of data search and data representation in a coal mine information retrieval system, 2:55711
Faiziev, Sh.A., *See* Koltun, M.M., 2:56055
Faletti, D.W., *See* Allemann, R.T., 2:56345
See Braun, D.J., 2:56241
See Zaloudek, F.R., 2:56236
Fan, P., *See* McMurtry, G.M., 2:56189
Fano, U., Analysis of electron correlations, 2:57518
Faoro, R.B., National trends in trace metals in ambient air, 1965—1974, 2:57354 (EPA—450/1-77-003)
Farcasiu, M., Kinetics and mechanisms of solvent refining coal, 2:55619 (CONF-760885—, pp 101-124)
Farello, G.E., *See* Cumo, M., 2:56395
Farhadieh, R., Flow regime of hydrodynamically unstable melting systems, 2:56836
Farhataziz, Ultraviolet part of transient absorption spectrum induced in liquid ammonia by nanosecond pulse radiolysis, 2:57237
Farkas, F., Development of brown boveri gas turbine compressors, 2:56264
Farmakes, R., Transactions of the Iran conference on the transfer of nuclear technology held April 10—14, 1977, in Persepolis/Shiraz, Iran, 2:56630
Transactions of the American Nuclear Society 1977 annual meeting, New York, NY, June 12—16, 1977, 2:57804
Farmer, A.A., Nuclear fuel cycle: (4) the reactors, 2:56606
Farnsworth, D.A., *See* Heller, A.S., 2:56864
Farr, W.M., *See* Murphy, D.J. Jr., 2:55926
Farrar, L.C., *See* Quapp, W.J., 2:56808
Fartukov, S.V., *See* Shterenshis, I.P., 2:56687
Faruki, F.I., *See* Buniyat-Zade, A.A., 2:57172
Fastrup, B., Experimental studies of inner-shell excitation in slow ion-atom collisions, 2:57536
Faugeras, P., Low temperature steam generator, 2:56459
Faust, J.W. Jr., *See* Hilborn, R.B. Jr., 2:56035
Fedorov, E.M., *See* Zinger, N.M., 2:57010
Fedoseenko, A.V., Determination of the permissible deflection of boiler headers at steam power plants, 2:56290
Fedosova, V.Y., *See* Bochkarev, G.R., 2:55653
Feigin, S.E., *See* Kolyada, G.I., 2:56229
Feinberg, F.L., Non-Abelian gauge fields and nonrelativistic bound states, 2:57579
Feinroth, H., Emerging role of FEA in nuclear energy expansion, 2:56939
Feit, G.N., *See* Khodot, V.V., 2:55736
Fejes, P., Water chemistry in Swedish boiling water reactors: operational experience, 2:56376
Feldman, D.W., *See* Sprague, J.W., 2:57087
Felix, P., *See* Koch, H., 2:56347
Felix, P.C., Corrosion and its prevention in modern stationary gas turbines, 2:56262
Feltz, L.V., *See* Blackwell, B.F., 2:56222
Fenimore, J.W., Status report: borehole monitoring of radioactive waste trenches 1965—1974, 2:55932 (DPST—76-254)
Feraday, M.A., Preparation of mixed oxide nuclear fuel, 2:55874
Ferdinande, V., Energy recovery from sea waves with the aid of oscillating floating bodies, 2:56217
Ferranti, P., *See* Caldarola, L., 2:56646
Ferrari, G., *See* Campolunghi, F., 2:56562
See Cumo, M., 2:56395
Ferrell, W.L., Loss-of-coolant accidents in lithium-cooled fusion blankets, 2:57744
Fessler, H., Stress analysis of finned-tube water-walls of boilers, 2:56282
Feuerstein, H., *See* Mitsutsuka, N., 2:56514, 2:56515
Fiarman, S., Monte Carlo calculations of cadmium cutoff energies and an ansatz formula, 2:56759
Fickert, W., Activity measuring point, especially in a nuclear power station, 2:57334
Fiebelmann, P., *See* Kottowski, H.M., 2:56607
Field, R.J., Mechanisms of chemical oscillators: conceptual bases, 2:57215
Fields, G.S., Centrifugal air precleaner for internal combustion engines, 2:57049
Fikus, F., Distribution of the density of induced current along the height of an operational duct on an electrodynamic pump, 2:57306
Filip, R., *See* Brumovsky, M., 2:56873
Filippov, G.A., Investigation of the turbine separator stage with increased axial gap, 2:56286
Fillo, J., *See* Powell, J., 2:57793
Fillo, J.A., Catalyzed D-D and D-^{3}He fusion blanket designs, 2:57727
Fusion blanket first-wall time-dependent thermal stress model, 2:57730
Thermal-hydraulic and neutronics analysis of an SAP-thermosyphon blanket, 2:57729
Finch, R.E., Carbonate leach uranium ore processing with sodium polyacrylate flocculant, 2:55863
Finger, M., *See* Kury, J.W., 2:57349
See Lee, E.L., 2:57348
Finlayson, F.C., Assessment of emergency core cooling system effectiveness for light water nuclear power reactors, 2:56881
Finney, B.C., *See* Pechin, W.H., 2:55936
Fiore, N.F., Microstructural effects in abrasive wear. Quarter progress report, 15 March 1977—15 June 1977, 2:57104 (COO—4246-1)
Firth, D., *See* Bentley, P.G., 2:56568
Fischer, A.K., Trapping efficiency of molten lithium for 20-keV tritium ions, 2:57497
Fischer, D.D., Report on the successful development of underground coal gasification at Hanna, Wyoming, 2:55562 (CONF-770510—8)
Fischer, P.G., Behaviour of tritium in a graphite reactor, 2:56441
Fischer, S.R., *See* Chen, Y.S., 2:56810
Fish, J.D., Radiolytic production of chemical fuels in fusion reactor systems, 2:57786 (COO—3028-28)
Fish, R.L., *See* Garkisch, H.D., 2:56755
Fisher, P.W., Cryosorption pumping of helium at 4.2 K by Type 5A molecular sieve, 2:57797
Fisk, G.A., Requirements for optimum chemical recoverability in photolytically pumped atomic iodine lasers, 2:57285 (SAND—76-9310)
Fitch, B., *See* Brenner, H., 2:55600
Fiterman, Ya.F., *See* Gal'perin, M.I., 2:56009
Fitzgerald, L.D., *See* de Winter, F., 2:56142
Flagella, P.N., Low cycle fatigue testing in flowing sodium at elevated temperatures, 2:56521 (CONF-760503—P1, pp 353-358)
Flaks, I.P., *See* Ogurtsov, G.N., 2:57516
Flanigan, L.J., *See* Carbiener, W.A., 2:56767
Flesher, D., *See* Jackson, W.A., 2:57419
Fletcher, P.B., Small bus program: vehicle operation efficiency report. Part I. experimental bus program (15-20 passenger buses). Part II. Van conversions for dial-a-ride service (12 passenger buses), 2:56941 (PB—265131)
Flores, R.A., *See* Geigel, M.A., 2:55596
Florschuetz, L.W., Extension of the Hottel-Whillier-Bliss model to the analysis of combined photovoltaic/thermal flat plate collectors, 2:56067
See Evans, D.L., 2:56068
Flott, A.C., Ton-mile, does it properly measure transportation output, 2:57023
Flunkert, F., *See* Andres, O., 2:56663
Flynn, L., Fuel economy. Subject bibliography, 2:57024 (PB—265387)
Foch, P., Coke production: metallurgical coke, foundry coke, molded coke, 2:55550
Foerg, W., *See* Mueller, K., 2:55813
Foerster, S., Cooling of nuclear power plants equipped with high-temperature reactors and helium turbine cycles, 2:56443
Fofanov, Y.A., *See* Melnikov, N.A., 2:57289
Folkers, C.L., *See* Singleton, M.F., 2:57799
Folkmann, F., *See* Mokler, P.H., 2:57542
Fomina, A.S., *See* Nappa, L.A., 2:55846
Fontana, M.H., *See* Han, J.T., 2:56818
Fontenot, D.R., *See* Hershman, M.J., 2:56958
Forbes, I.A., *See* Morris, C.J., 2:56622
Forestieri, A.F., *See* Anagnostou, E., 2:56042
See Weinberg, I., 2:56043
Forostov, V.M., *See* Korolenko, Yu.A., 2:57303

Forsberg, J.W., Method of rerefining oil with recovery of useful organic additives, 2:55790
Forstner, J.L., *See* Perkins, W.C., 2:55880
Fortescue, P., Comparative breeding characteristics of fusion and fast reactors, 2:57748
Fortune, P.J., *See* Wahl, A.C., 2:57501
Fossum, A.F., *See* Callahan, G.D., 2:57475
See Ratigan, J.L., 2:55914
Foster, C.A., Fueling by high-speed pellet injection, 2:57750
See Wendelken, J.F., 2:57343
Foster, E.L. Jr., Heat source component development program. Quarterly report for April—June 1977, 2:55973 (BMI-X—683)
Foster, S.J., *See* Davis, D.E., 2:56713
Fouillac, C., *See* Michard, G., 2:56193
Fourest, B., *See* Fruchard, Y., 2:56580
Fournier, R.O., *See* Truesdell, A.H., 2:56209
Foust, O.J., Industrial subcontractor team looks at TFTR, 2:57697
Fowler, M.M., *See* Hulet, E.K., 2:57601
Framba, B., *See* Cogliati, A., 2:57027
Frank, H., Natural gas: feedstock for ethylene plants, 2:55808
Frank, M.V., Coupled fission gas release and molten fuel motion model for slow overpower transients, 2:56855
Frank, T., *See* Devaney, J., 2:57764
Frank, T.G., Inertial confinement fusion reactor and generating station concepts, 2:57774
Franklin, J.C., *See* McVey, J.R., 2:55861
Franks, L.A., Technique for measuring optical fiber transmission using the time dispersion of Cerenkov radiation, 2:57309
Franz, S., Heterojunction solar cells of SnO_2/Si, 2:56047
Fraser, D.B., Canadian non-fuel minerals in the international scene and foreign policy, 2:56932
Frass, F., Temperature increase in the contact of elements with internal heating at high heat flux densities, 2:56647
Frederick, N.V., *See* Jones, M.C., 2:56360
Frederking, T.H.K., *See* Okrent, D., 2:57761
Freedman, A., *See* Parr, T.P., 2:57511
Freedman, J.M., *See* Pope, R.B., 2:57280
Freeman, J.R., Radiation patterns from electron beam fusion targets, 2:57783
Frees, G., *See* Borgstedt, H.U., 2:56519, 2:56542
Freese, K.B., *See* Bartsch, R.R., 2:57661
Frenkel, L.D., *See* Mitor, V.V., 2:56316
Freudenthal, R.I., Toxicity of some of the organic emissions identified in the effluents from reprocessing nuclear fuel, 2:55938
Freymeyer, P., Safe operation of power plants. Pt. 1. State of technology concerning electrotechnical and control equipment in thermal power plants, 2:56728
Safe operation of power plants. Pt. 2. Technical means for the optimal operation of nuclear power plants, 2:56729
Fricker, H.W., *See* Huddle, R.A.U., 2:56455
Friedberg, E.C., *See* Slor, H., 2:57433
Friedland, A.J., *See* Carelli, M.D., 2:56530
Friedman, L., *See* Beuhler, R.J., 2:57495
Frisch, A.F., *See* Williamson, T.G., 2:57339
Frish, A.E., *See* Shpil'rain, E.E., 2:56998
Fritts, D.H., Electrode assembly for bipolar battery, 2:56903
Fritzsche, W., *See* Schweiger, F., 2:56453
Froehlich, G., Experiences with vapor explosions caused by entrapment of water with melts, 2:56868
Fruchard, Y., Experimental studies on sodium fires application to reactors, 2:56580 (NP-tr—1980)
Frye, J.C., Summary of geologic review group meeting, January 20—21, 1977, 2:55919 (Y/OWI/TM—8/1)
Fryer, B.C., *See* Braun, D.J., 2:56241
Fuchs, V., Three-wave parametric-decay instability with arbitrary dissipation in homogeneous plasmas, 2:57669
Fuge, C., *See* Sohns, D., 2:57040
Fujimura, T., *See* Hasegawa, M., 2:56540
Fujino, M., Apparatus for inspecting failed fuel, 2:56399
Apparatus for inspecting failed fuel, 2:56400
Fujishiro, T., Cladding temperatures, deformations, and failure thresholds during power bursts, 2:56807
Fukagawa, M., *See* Kitagawa, M., 2:56676
Fukuda, F., *See* Ueda, Y., 2:57262
Fukuda, M., *See* Hatano, M., 2:55628
Fukuda, S., *See* Aoki, T., 2:55868
Fukushima, Y., *See* Naito, K., 2:56571
Fulford, P.J., Educational aspects of reactor calculations for fuel management, 2:56597
Fuller, S.H., *See* McWilliams, T.M., 2:57828
Fullwood, R.R., Data and assessment of human factor impact on nuclear reactors, 2:56860
Preliminary risk analysis of the transportation of nuclear waste, 2:55948
See Erdmann, R.C., 2:55945
Fumero, R., Functional and structural performances of radioisotope power sources for artificial heart, 2:55972
Funahashi, A., *See* Takeuchi, H., 2:57642
Furth, H.P., Role of the TFTR in the development of tokamak physics, 2:57695
Furuta, T., *See* Honma, K., 2:56783

G

Gabel, R., Primary energy consumption of the Federal Republic of Germany in 1976, 2:56983
Gabzdyl, W., *See* Duzniak, S., 2:55663
Gaca, W., Pressing of cement pastes, as well as the possibilities of utilizing this method for the purpose of determination of the quality of the cement, 2:57166 (LA-tr—77-26)
Gaertner, E., Surface mining of brown coal, its environmental influence and future prospects: illustrated by the example of the Rhenish brown coal mining industry, 2:55669 (AED-CONF—76-417-001)
Gahn, R.F., *See* Reid, M.A., 2:57000
Gallar, O.H., *See* Herczeg, J.W., 2:56805
Gal'perin, M.I., Specific features of construction and assembly of rotor chambers of large rotary blade hydraulic turbines, 2:56009
Gala, A., *See* van Heek, K.H., 2:55593
Galbraith, D.L., Parametric investigation of mirror reactor dynamics, 2:57633
Galioto, T.A., *See* Hoffman, N.J., 2:56498
See Whitlow, G.A., 2:56494
Galstaun, L.S., Process for the methanation of gases containing high concentration of carbon monoxide, 2:55987
Galvin, T.M., *See* Wrona, B.J., 2:56854
Gambs, G.C., Report on coal. Status report of the Ad Hoc Committee on Energy Resources and Technology of the Atomic Industrial Forum, March 1975, 2:55658 (NP—22116)
Ganapol, B.D., *See* Murphy, D.J. Jr., 2:55926
Gandel'sman, A.F., *See* Shpil'rain, E.E., 2:56998
Gandrey, L., Production of components for pressurized water reactors in the plants of FRAMATOME, 2:56421
Production of components for pressurized water reactors in the plants of Framatome, 2:56422
Gannon, R.E., *See* Ubhayakar, S.K., 2:55559
Gantzel, P.K., *See* Chin, J., 2:57155
Ganponenko, L.N., *See* Parshin, A.A., 2:56273
Gardent, P., New developments in the French coal plan, 2:56963
Gardner, G.W., *See* King, S.B., 2:55561
Gardner, R.I., State of the implementation of SARA, 2:57820 (UCLA—34P214-40)
Garfinkel, M., Large area silicon sheet task low-cost silicon solar array project. Fifth quarterly progress report, January 1, 1977—April 1, 1977, 2:56036 (ERDA/JPL/954350—77/1)
Garg, I.D., *See* Singal, R.K., 2:56685
Garkisch, H.D., Clinch River Breeder Reactor Plant. Flow induced vibration of fuel rods in CRBRP, 2:56533 (CRBRP-ARD—0166)
Clinch River Breeder Reactor Plant. Irradiated EBR-II duct crushing test and analysis, 2:56755 (CRBRP-ARD—0164)
Garkusha, A.V., *See* Shnee, Ya.I., 2:56305
Garner, P.L., Importance of the solification of fuel condensate, 2:56851
See Kennedy, M.F., 2:56821
Garrett, B.B., *See* Baisden, P.A., 2:57229
Garribba, S., DICOMICS-TWIN: self-adaptive algorithm for minimal cut sets determination from fault trees, 2:56866
Garrity, W.E., *See* Chang, E.C., 2:56670
Gasho, T.V., *See* Antikain, P.A., 2:57132
Gatel'skii, G.V., *See* Sirota, A.N.N., 2:57188
Gates, O., *See* Warren, S., 2:57435
Gauslow, R.W., *See* Jones, T.A., 2:56656
Gauvenet, M., Radioactive residual matter. II, 2:55728
Gavin, B.F., *See* Hulet, E.K., 2:57601
Gavrilov, B.G., Mixture formation in diesel engines, 2:56991
Gavrilov, N.N., *See* Titushkin, V.A., 2:55844
Gavrilov, V.V., *See* Aluker, E.D., 2:57187
Gavrilyuk, A.I., Electrochromism in V_2O_5 films, 2:57161
Gazdag, J., *See* Secen, J., 2:55749
Geballe, R., *See* Risley, J.S., 2:57517
Gebelein, H., Rekatic, a control and monitoring system for transformer stations, 2:56353
Gehl, S.M., *See* Rest, J., 2:56372
Geigel, M.A., Coal liquefaction by alkylation, 2:55596 (CONF-760885—, pp 34-39)
Gelles, S.H., Analytical study of space processing of immiscible materials for superconductors and electrical contacts. Final report, 28 May 1975 - 30 Sep. 1976, 2:57092 (N—77—16075)
Gent, C.W., Process for producing combustible gases, 2:55984
Gentili, A., *See* Castellani, F., 2:55907
Gentry, W.R., Long-range interactions of ions with atoms having partially filled p subshells, 2:57513
See McClure, D.J., 2:57514
Genung, R.K., *See* Mrochek, J.E., 2:57201
Georges, J.M., *See* Martin, J.M., 2:55775
Gephart, R.E., *See* Arnett, R.C., 2:57397
Gerard, A., Fiscal year 1976/health and environmental effects research program abstracts, 2:57360 (PB—265381)
Gerasimov, V.S., *See* Nudel', A.M., 2:56686
Gerstner, H.B., *See* Huff, J.E., 2:57445
Gervais, F., Observation of nonlinear Landau damping of a broad-band

spectrum of electron plasma waves, 2:57677
Gheorghe, Ad.V., Systems engineering applications for safety models in nuclear reactors, 2:56879
Ghiorso, A., *See* Hulet, E.K., 2:57601
Ghose, S., *See* Chatterjee, C.N., 2:55666
Ghose, S.K., *See* Aronstein, R.E., 2:57704
Ghosh, P.C., Prereduction of iron ore, 2:55667
Gibbons, J.H., Environmental implications of nontechnological methods to conserve energy, 2:56924
Gibson, B.F., *See* Berman, B.L., 2:57612
Giese, C.F., *See* Gentry, W.R., 2:57513
Gieseke, J.A., Aerosol measurements and modeling for fast reactor safety. Task 7. Quarterly progress report, October 1—December 31, 1976, 2:56768 (BMI-NUREG—1969)
Gieske, J.H., Ultrasonic data acquisition, analysis, and display by minicomputer aided techniques, 2:57308 (SAND—77-0526C)
Gilbert, K.J., *See* Fullwood, R.R., 2:56860
Gilbert, R.O., *See* Doctor, P.G., 2:57379
Gilcrest, J.D., *See* Rubinstein, H.J., 2:55892
Gilinskii, M.M., Linearized nonequilibrium flow of a combustible mixture during interaction of two supersonic gas streams, 2:57246
Gillespie, W., *See* Byers, L., 2:55784, 2:55786
Gilligan, J.E., Weatherability of solar energy utilization materials: preliminary discussions, 2:56146
Gilligan, J.G., Time reduction techniques for neutral atom transport by multigroup methods, 2:57649
Gilman, F.M., *See* Brau, C., 2:57496
Gimel'shein, L.Y., Some problems of formalization of the process of introduction of research results into production, 2:55710
Ginsberg, T., Role of condensation on dispersion of closed boiling UO_2 systems, 2:56843
See Tsai, S.S., 2:56823
Giordano, G., Fiat HI-control system for Fiat gas turbines, 2:56278
Girardi, F., Long-term risk assessment of radioactive waste disposal in geological formations, 2:55951
Giroux, E.D., Implementation of the large mathematical model HEMP on the STAR-100 computers, 2:57822 (UCRL—52277)
Gitel'man, A.L., *See* Popov, E.F., 2:56319
Gladd, N.T., *See* Davidson, R., 2:57667
Glancy, J., *See* Siri, W.E., 2:55957
Glaze, J.A., Geometrical theory of nonlinear phase distortion of intense laser beams, 2:57286 (UCRL—76834)
Glebov, V.P., *See* Zubov, I.V., 2:56291
Glenn-Lewin, D.C., *See* Voight, J.R., 2:55671
Glikina, F.B., *See* Balezin, S.A., 2:56256
Gloria, I.V., *See* Tsui, B.M.W., 2:57439
Glowienka, J., *See* Miley, G.H., 2:57767
Gloyna, E.F., *See* Frye, J.C., 2:55919
Glushko, V.V., Direction of exploration and possibilities of hydrocarbon pool discoveries in the Volyno-Podolian area, 2:55747
Gluskoter, H.J., Inorganic sulfur in coal, 2:55645
Gnirk, P.F., Analysis and evaluation of the rock mechanics aspects of the proposed salt mine repository. Summary progress report RSI-0005, 2:55908 (ORNL/SUB—3706/2)
Elastic solutions for selected circular-symmetric problems as applied to the design of the waste-container sleeve. Technical memorandum report RSI-0007, 2:55909 (ORNL/SUB—3706/4)
See Grams, W.H., 2:57329
Goeser, D.K., *See* Penland, J.R., 2:56771
Gofaizen, A.V., Hydraulic resistance of supporting throttling washers, installed in horizontal pipes, to two-phase flow, 2:57302
Gohar, Y., High-Z spectral shifter in a fusion reactor, 2:57726
Gohshi, Y., *See* Mitsutsuka, N., 2:56514, 2:56515
Gokhberg, B.M., Cross section for fission of ^{244}Pu by fast neutrons, 2:57608
Gol'denfarg, I.N., *See* Parshin, A.A., 2:56321
Golay, M.W., *See* Chan, J.K., 2:56240
See Todreas, N.E., 2:56531
Golden, D., *See* Stein, S., 2:55634
Goldenbaum, G.C., *See* Allen, A.W., 2:57671
Goldgraben, G., *See* Bliss, C., 2:56923
Golob, J., *See* Franks, L.A., 2:57309
Gologorskii, I.D., *See* Prikhod'ko, M.S., 2:56246
Golovach, E.A., Analysis of the control system of a high-capacity turbine for a nuclear power plant, 2:56735
Selection and investigation of turbine capacity control system for nuclear power plants, 2:56730
Golovachev, Yu.P., *See* Zhukovskii, M.I., 2:56008
Golovanov, N.V., *See* Mitor, V.V., 2:56316
Golovner, T.M., *See* Bordina, N.M., 2:56052
Gombolevskii, V.I., *See* Gofaizen, A.V., 2:57302
Gombosy, T., *See* Gringauz, K.I., 2:57489
Gomm, H., Technical innovations in solution mining and their application in the federal Etzel cavern project, 2:55803
Gonchar, V.Y., Limits of nuclear stability, 2:57615
Self-consistent calculation of the neutron and proton densities of nuclei, 2:57613
Goncharov, A.I., Investigation of aerodynamics, ignition and burnout of spray in the furnace of a BKZ-420-140-1 boiler with twinned vortex burners of ekibastuz coal, 2:55729
Gondoh, H., *See* Shikoh, S., 2:57261
Goodman, L.S., *See* Childs, W.J., 2:57504
Goodman, N.B., Use of solid-dielectric compound parabolic concentrators with photovoltaic devices, 2:56074
Goranson, R.B., *See* Bartlett, J.W., 2:55942
Gorbanenko, A.D., *See* Krutiev, V.A., 2:55805
See Rybalko, V.K., 2:57320
Gorbaty, M.L., *See* Aczel, T., 2:55635
Gordeev, Y.S., *See* Afrosimov, V.V., 2:57637
Gordon, C.W., Parameter matching for the breeding blanket, 2:57728
Gorynin, I.V., *See* Balandin, Yu.F., 2:56694
Goshdzhanov, M., *See* Rakhmanov, A., 2:56101
Goto, S., *See* Koba, A., 2:56703
Goto, T., Door valve, 2:56572
Gottstein, K., Peaceful utilization of nuclear energy: effects on the policy of security in the Federal Republic, 2:56882 (ERDA-tr—273)
Gouguel, J., Geothermal heat, 2:56173
Gould, D.J., *See* Worrell, R.B., 2:57831
Gozani, T., Prompt-neutron activation analysis: applications to coal analysis, 2:57191
See Siri, W.E., 2:55957, 2:55958
See Verbinski, V.V., 2:55714
Grace, J.N., Role of TFTR, 2:57694
Graf-Webster, E., *See* Bliss, C., 2:56923
Graham, L.W., Materials for advanced high temperature reactors, 2:57139
Graham, R.A., Measurement of wave profiles in shock-loaded solids, 2:57156 (SAND—77-1056C)
Grainick, S.L., Fueling problem, 2:57749
See Gilligan, J.G., 2:57649
Grams, W.H., Analysis of the custom design/fabrication/testing requirements for a large-hole drilling machine for use in an underground radioactive waste repository, 2:57329 (Y/OWI/SUB—4269/22)
Granda, J.J., Studies of design parameters in the fabrication of Nb—Al—Ge superconductors by the powder metallurgy infiltration method, 2:57091 (LBL—5772)
Granovskii, Ya.L., Power engineering branch system of scientific and technical information in the tenth five year plan period, 2:56230
Grant, V., *See* Gross, M.G., 2:57391
Grasso, H.O., *See* Quihillalt, O.J., 2:56636
Grauer, W.M., *See* Berg, M.E., 2:57240
Grauman, D.W., TNS scoping studies, 2:57706
Graves-Morris, P.R., *See* Baker, G.A. Jr., 2:57829
Gray, J.A., Success at Westfield, 2:55587
Success at Westfield, 2:55592
Grebennikova, T.T., *See* Antikain, P.A., 2:57132
Grebogi, C., Upper-hybrid-resonance absorption of laser radiation in a magnetized plasma, 2:57686
See Tripathi, V.K., 2:57668
Green, D.R., *See* Stein, N.A., 2:57566
Green, D.W., Thermodynamic functions and vapor pressures of uranium and plutonium oxides at high temperatures, 2:55867 (CONF-770537—2)
Green, H.P., Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Ownership issues: alternative structures for creating a commercial coal liquefaction industry. Final report, January 1975—December 1976, 2:55604 (FE—1752-15)
Green, L.G., *See* Kury, J.W., 2:57349
Green, M.V., Studies of the heart with ECG-gated scintigraphy, 2:57421
Green, R.M., High temperature thermal energy storage, 2:56154
Greene, D.A., Small leak damage and protection systems in steam generators, 2:56508 (CONF-760503—P1, pp 233-241)
Greene, J.M., *See* Chance, M.S., 2:57663
See Rosen, M.D., 2:57629
Greenspan, E., Feasibility of plutonium separation-free nuclear power economy with LWHRs, 2:56550
Greenstreet, W.L., Feasibility study of prestressed concrete pressure vessels for coal gasifiers, 2:55583 (ORNL—5312)
Gregg, D.W., Ground subsidence resulting from underground gasification of coal, 2:55584 (UCRL—5225)
Greiner, W., *See* Betz, W., 2:57557
Grekova, L.D., *See* Angelov, N., 2:57571
Grenon, M., Energy and natural resources, 2:56930
Oil in Indonesia, 2:55795
Gresser, H., *See* Martin, C., 2:57654
Grether, D., *See* Berdahl, P., 2:56138
Gribble, R.F., *See* Bartsch, R.R., 2:57661
Gribelyuk, I.I., *See* Zakhidov, R.A., 2:56124
Gridasov, V.I., *See* Abramov, V.V., 2:57565
Griffin, J.F. Peterson, J.B., Safety Analysis Report for Packaging (SARP): ATMX-500 Railcar nuclear packaging, 2:57277 (MLM—2428)
Griffin, P.M., Extreme ultraviolet spectra of highly stripped silicon ions, 2:57219
Griffith, C.M., *See* Singleton, M.F., 2:57799
Griffith, R.W., Solar energy utilization, solid state science, and a high efficiency amorphous-silicon absorber, 2:56141

Grilikhes, V.A., Conjugated cycles of single-loop solar energy refrigerating plants, 2:56084
Grimes, S.M., *See* Haight, R.C., 2:57594
Grimm, E.A., High-density fuel storage for boiling water reactors, 2:56370
Grimm, R.C., *See* Chance, M.S., 2:57663
Grin'ko, N.K., Principal lines of development of science and technology in the tenth five-year plan period, 2:55688
Grinberg, I.M., *See* Luce, R.G., 2:56988
Gringauz, K.I., Electron currents measured in the optical shadow of Venus by the "Venera-9" and "Venera-10" satellites; the basic source of ionization in the nightside ionosphere of Venus, 2:57489
Grishin, V.G., *See* Angelov, N., 2:57570, 2:57571
Grishin, Yu.M., Formation of plasma focus in erosion-type plasma accelerators. II, 2:57659
Groen, J.M., Basic solar energy balance, 2:56110
Grolmes, M.A., *See* Ishii, M., 2:56853
Gromov, N.K., Principles of design of schemes of district heating systems in cities, their automation, and installation of remote control facilities, 2:56913
Grooms, D.W., A directory of computer software applications: energy. Report for 1974—1976, 2:56909 (PB—264200)
Gross, M.G., Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976—30 June 1977, 2:57391 (COO—3292-28)
Grosser, E.D., *See* Dietz, W., 2:56517
Grover, R., Metallic high pressure equation-of-state derived from experimental data, 2:57106 (UCRL—79032)
Gruber, R., *See* Chance, M.S., 2:57663
Gruen, D., *See* Cafasso, F., 2:57789
Gruen, D.M., HYCSOS: a chemical heat pump and energy system based on metal hydrides, 2:57002 (ANL—77-39)
Grutt, E.W. Jr., Uranium exploration methods development, 2:55858
Gruzdev, N.I., Behavior of active products of corrosion in the system of a channel-type boiling-water nuclear power reactor of a single-loop nuclear power plant, 2:56379
Grzesik, J., Kinetic energy release in missile ejection from confining magnets, 2:57733
Guard, R.F.W., Heavy water reactor best option for technology transfer, 2:56461
Guccione, E., Health hazards of not going nuclear, 2:56938
Guffey, F.D., *See* King, S.B., 2:55561
Gukeisen, C., *See* Wolz, G.C., 2:56502
Gulezian, G.V., *See* Moeller, D.W., 2:57432
Gulin, E.I., Effect of hydrocarbon groups and fractional fuel compositions on ignition and combustion processes in diesel engines, 2:57062
See Zelenin, N.I., 2:55850
Gullickson, R.L., Operation of a plasma-focus device with D_2 and He^3, 2:57653
Gunn, R.D., Problems solved and problems not solved in UCG, 2:55560 (CONF-770510—6)
Gunnerson, F.S., Correlation for the Leidenfrost temperature for spherical particles and its application to FCI analysis, 2:56857
Guon, J., *See* Bauerle, G., 2:56163
Gupta, R., Hyperfine structure of the highly excited states of alkali atoms, 2:57507
Gusev, V.F., *See* Andreev, V.A., 2:57042
Guterman, M.B., *See* Trusov, L.P., 2:56255
Guy, A.L. Jr., Method and apparatus for connecting two or more components of an offshore platform, 2:55759
Guzhov, N.P., Multifactorial model of technical and economic indices of performance of thermal power plants, 2:56232
Gwynn, J.D., State of the art, 2:56216

H

Haake, N., *See* Butterfield, C.E., 2:56454
Haarman, R.A., Electrical breakdown and tracking characteristics of pulsed high voltages in cryogenic helium and nitrogen, 2:57742
Habenschuss, A., *See* Spedding, F.H., 2:57214
Hachey, D.L., *See* Klein, P.D., 2:57407
Hadley, H. Jr., *See* Meakin, J.D., 2:56070
Haferkamp, D., *See* Horner, M., 2:56432
Haffner, D.R., Evaluation of LMFBR performance characteristics in the U.S. nuclear energy system, 2:56547
Hafter, E.R., Lateralization model and the role of time-intensity tradings in binaural masking: Can the data be explained by a time-only hypothesis, 2:57426
Hageman, R.H., *See* Jackson, W.A., 2:57419
Hagenbuch, F.H., *See* Purvis, D.G., 2:55672
Hagenson, R.L., *See* Krakowski, R.A., 2:57719
Haglund, D.R., *See* Garkisch, H.D., 2:56755
Hagmann, S., *See* Mokler, P.H., 2:57542
Hagn, L., Fatigue damage on large components, 2:56692
Haight, R.C., Hydrogen and helium production cross sections for 15-MeV neutrons on types 316 and 304 stainless steel, 2:57594
Hakamata, K., *See* Hiraga, S., 2:56188
Hakao, Z., Experimental study on roadway swelling in coal mines--1. Effect of roadway depth on swelling, 2:55668
Halama, H.J., *See* Chou, T.S., 2:57785
Hale, G.M., *See* Dei, D.A., 2:57754
Hall, A.M., Testing, identification, and evaluation of commercial and "advanced experimental" materials and coatings under design conditions simulating fuel power cycle combinations. Task II. Evaluation of heat exchanger materials for use in coal-fired fluidized bed combustion environment. Monthly technical progress report No. 14, 2:55725 (FE—2325-14)
Hall, C.A., Thermal storage by paired ammoniated salts, 2:56151
Hall, E.H., Characterization of industrial process heat, including the potential for solar or nuclear systems to supply this market, 2:56094
Hall, R.N., *See* Garfinkel, M., 2:56036
Halpern, H.J., *See* Stein, N.A., 2:57566
Halpert, G., *See* Mcdermott, P., 2:56888
Hamawi, J.N., AEOLUS: atmospheric dispersion and finite-cloud doses during normal, sea-breeze, and accident conditions, 2:57372
Hamilton, L.D., Health hazards of alternative electricity generation fuel cycles, 2:57404
Hammelmann, K., *See* Angelini, A., 2:56732
Hammer, H., Synthesis of substitute natural gas based on coal, 2:55586
Hammerstrom, J.G., *See* Zen, E., 2:55848
Hampel, G., *See* Andres, O., 2:56663
Hampel, V.E., Time for atomic and molecular data bases is now (an overview of data management research at LLL), 2:57832 (UCRL—79286)
Hamrin, C.E. Jr., Catalytic activity of coal mineral matter. Interim report, April—September 1976, 2:55626 (FE—2233-2)
Han, J.T., Edge blockages in 19-pin sodium-cooled bundles, 2:56818
Handel, H., *See* Angelini, A., 2:56732
Hands, B.A., *See* Jones, M.C., 2:56360
Handy, L.E., *See* Bartsch, R.R., 2:57661
Hang, D.F., Economic computations in the fuel cycle, 2:56596
Hann, C.R., *See* Williford, R.E., 2:56708
Hansel, J.M., Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57197 (LA—6869)
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57198 (LA—6869-MS)
Hansen, K.C., Process feasibility study in support of silicon material Task I. Quarterly technical progress report (VII), 2:56034 (ERDA/JPL/954343—77/2)
Hansford, J.D. Jr, *See* Bender, F.E., 2:56092
Hanslik, T., *See* Cech, B., 2:55884
Hanson, T.J., Determination of aluminum by four analytical methods, 2:57199 (ARH-ST—131)
Hara, K., *See* Kobayashi, H., 2:57217
Hara, Y., *See* Sakai, Y., 2:56190
Hardee, H.C., Natural convection in porous media with heat generation, 2:56801
Hardie, R.W., *See* Haffner, D.R., 2:56547
Hardy, H.R. Jr., Study of microseismic activity associated with a longwall coal mining operation using a near-surface array, 2:55657
Hardy, J.R., Theoretical studies of soliton-like behavior of shocks in one-dimensional systems, 2:57623 (UCRL—79259)
Hare, M.G., Steam generator tube failures: world experience in water-cooled nuclear reactors in 1975, 2:56397
Hariram, S.S., Evaluation of valves for Cresap testing, 2:55602 (FE—1517-24)
Harling, O.K., *See* Behrisch, R., 2:57494
Harms, A.A., Conversion efficiency enhancement in neutron radiography, 2:57310
See Gordon, C.W., 2:57728
See Trojan, O.A., 2:56627
Harrington, R.E., *See* Zama, M., 2:57411
Harris, G.S., Energy scenarios for New Zealand. Report No. 19, 2:56955 (NP—22250)
Harris, J.M., *See* Borders, J.A., 2:57189
Harris, W.B., *See* Davison, R.R., 2:56116
Harrison, F.L., Impact and fate on aquatic environments of copper from nuclear power plants, 2:57446
Harrison, R.P., Failure assessment of pressure vessels under yielding conditions, 2:56675
Harstead, G.A., *See* Soeoet, O., 2:56655
Hart, D.W., *See* Koetzle, T.F., 2:57209
Hart, S.R., *See* White, W.M., 2:57476
Hartenau, B., *See* Siri, W.E., 2:55957
Hartman, H., *See* Reiter, M., 2:56177, 2:56182
Hartmann, C., Comparison between regenerative and recuperative heat recovery systems in ventilating plants, 2:57045
Hasebe, N., *See* Kamada, N., 2:57050
Hasegawa, M., Sodium environment effects to structural materials for fast reactors, 2:56540 (PNC-J—225-76-02)
Hashimoto, K., *See* Ujihira, M., 2:55690

Hashimoto, M., *See* Honma, K., 2:56783
Hatano, M., Effect of coke properties on blast furnace operation, 2:55628
Hawryluk, R.J., *See* Davis, S.L., 2:57632
Hawtin, P., *See* Clement, C.F., 2:56525
Hay, E., Modelling and analysis of the PFR superheater toroidal header, 2:56555
Hay, P.J., Geometries and energies of the excited states of O_3 from ab initio potential energy surfaces, 2:57503
Hayashi, Y., Direct cooling refrigerator-freezers, 2:57017
Hayatsu, R., *See* Winans, R.E., 2:55636
Hayes, F.R., *See* Huang, T.C., 2:56820
Haynes, B.S., Production of nitrogen compounds from molecular nitrogen in fuel-rich hydrocarbon-air flames, 2:57244
Hazelrigg, G.A. Jr., Economic approaches to long-term energy source selection, 2:57700
Heath, S.D., Look at vocational training for the solar energy industry, 2:56109
Hecht, M.J., Self-consistent normal fluid equation-of-state for (U,Pu)N, 2:56849
Hecker, R., *See* Fischer, P.G., 2:56441
See Serpekian, T., 2:56431
Heddleson, F.A., Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I—VI, 2:56787 (ORNL/NUREG/NSIC—136)
Hedrick, C.L., *See* Uckan, N.A., 2:57714
Hedrick, R.A., ORSLAP: a digital computer program for dynamic simulation of a multinode sodium loop during transients, 2:56788 (ORNL/TM—5322)
Heil, J.A., *See* Bloemen, H.A., 2:56536
Heiligenthal, G., *See* Betz, W., 2:57557
Heine, H.G., Electric conductive billet heaters, 2:57034
Heinecke, H.J., *See* Lange, K.H., 2:56228
Hejazi, M., *See* Abdel-Khalik, S.I., 2:57782
Hellen, T.K., *See* Hay, E., 2:56555
Heller, A.S., Probabilistic assessment of collisions involving nuclear vessels, 2:56765
Response surface methodology applied to thermal-hydraulic margin analysis, 2:56864
Heller, J.M. Jr., Isotopic effects on the electronic properties of H_2O and D_2O in the vacuum uv, 2:57221
Helm, F.H., *See* Lee, E.L., 2:57348
Henager, C.H. Jr., *See* Brimhall, J.L., 2:57146
Hench, T.L., *See* Burton, L.C., 2:56028
Hendrickson, P.L., Overview of economic, legal, and water availability factors affecting the demand for dry and wet/dry cooling for thermal power plants, 2:56237 (BNWL—2268)
Henin, R., *See* Reynen, J., 2:56383
Henley, E.M., Parity violation in atoms due to neutral weak currents, 2:57556
Hennebicq, J.P., Investigation of the functioning of an industrial process, 2:56424
Henner, V.K., *See* Vall, A.N., 2:57580
Hennessey, J.P., *See* Baker, R.W., 2:56226
Henry, E.A., *See* Hampel, V.E., 2:57832
Henry, R.E., *See* Cha, Y.S., 2:56813
Henry, R.N., Study of the mean particle diameter as related to the particle size distribution and the heat transfer rate from tubes immersed in a fluidized bed, 2:57297 (TID—27676)
Hepburn, F.J., *See* Jester, W.A., 2:57332
Herberg, G., Experiences on welding and testing during the construction of the austenitic reactor vessel for SNR 300, 2:56559
Herbst, E., Interstellar molecule formation, 2:57487
Herczeg, J.W., Comparison of one- and two-dimensional models of a control rod ejection accident in the HTGR, 2:56805
Herm, R.R., *See* Parr, T.P., 2:57511
Hermann, H.W., *See* Hertel, I.V., 2:57525
Hermann, W., Targeting in pipe networks of gas plants, 2:55811
Hermanson, W., Fabricate and evaluate protective canopies for 3-foot coal seams. Final report, 1975—1976, 2:55673 (PB—265073)
Hermelee, A.L., Regional reference energy systems, 2:56948 (EPRI-EA—462)
Herr, J.J., Standards for multilateral and world wide exchange of geothermal data, 2:56169 (LBL—6305)
Herrin, M., *See* Hoel, L.A., 2:56940
Herring, S., *See* Cohn, D.R., 2:57716
Hershman, M.J., Local regulation of pipeline sitings and the doctrines of Federal preemption and supremacy, 2:56958 (PB—265447)
Hertel, I.V., Electron scattering by laser-excited atoms, 2:57525
Herwig, L.O., Overview of the federal solar energy program and current technology status, 2:56014
Herzog, G., Angra-2 and -3 nuclear power plants in Brazil, 2:56414
Heumesser, G., Process computer in electric substations, 2:56350
Hewing, G., *See* Foerster, S., 2:56443
Hewitt, C.H., *See* Fletcher, P.B., 2:56941
Hiebert, A.L., Advanced composites: electromagnetic properties, vulnerabilities, and protective measures, 2:57167 (R—1979-AF)
Hieblinger, J., *See* Gomm, H., 2:55803
Hilborn, R.B. Jr., Web-dendritic ribbon growth. Quarterly report, January 1, 1977—March 31, 1977, 2:56035 (ERDA/JPL/954344—77/1)
Hill, D., *See* Auer, I.P., 2:57567
Hill, H.H., Electronic configurations and bonding in the early actinide metals, 2:57218
Hill, J.E., Initial test results for a solar-cooled townhouse in the mid-Atlantic region, 2:56106
Hills, L.V., *See* Chi, B.I., 2:57466
Himeno, Y., *See* Uematsu, K., 2:56578
Hinds, H.W., *See* Lepp, R.M., 2:56731
Hiraga, S., Seismometrical observation in Hakone volcano, 1973, 2:56188
Hirano, T., *See* Hirota, S., 2:56180
Hirol, H., *See* Sato, M., 2:56509
Hirota, S., Observation of temperature and water level in Hakone volcano, 1973, 2:56179
Observation of a newly appeared active fumarole at Owakudani, Hakone volcano, 2:56180
Hirsch, D.E., Developing empirical correlations from basic GPC data and deriving of fundamental GPC parameters for a given system, 2:57206 (BERC/RI—76/14)
Hirst, E., *See* Cohn, S., 2:57013
See Hoskins, R.A., 2:57014
Hitchcock, D.A., Neutral beam driven convective loss cone instability in toroidal geometry, 2:57670
Hittle, D.C., Method for estimating solar heating and cooling system performance, 2:56105
Hlozek, V., *See* Pailer, M., 2:55849
Hobart, M.A., *See* Jessop, A.M., 2:56207
Hobbs, W.E. Jr., Trapped particles and harmonic generation, 2:57675 (UCRL—13727)
Hobday, J.M., Development of coal-feeding systems at the Morgantown Energy Research Center, 2:55713 (MERC/RI—77/2)
Hodzic, A., *See* Horner, M., 2:56432
Hoel, L.A., Organizing and operating a vanpool program: feasibility of vanpooling in Virginia. Final report, 2:56940 (PB—264635)
Hofbauer, K., Study to improve downhole equipment for high-pressure gas wells, 2:55806
Hoffeins, H., *See* Zaugg, P., 2:56261
Hoffer, P.B., *See* Lim, C.B., 2:57422
Hoffman, J.M., Radiation coupling of Bernstein modes in a ring plasma, 2:57680
Hoffman, K.C., *See* Behling, D.J. Jr., 2:56954
Hoffman, N.J., Evaluation of cobalt and nickel base materials for sliding and static contact applications in a liquid metal fast breeder reactor, 2:56498 (CONF-760503—P1, pp 167-176)
Metallurgical problems associated with large sodium loop operations, 2:56485 (CONF-760503—P1, pp 60-66)
See Johnson, R.N., 2:56492
See Whitlow, G.A., 2:56494
Hogan, J.T., Impurity models for tokamaks, 2:57724
Hollabaugh, C.M., Chemical vapor deposition of tantalum on graphite cloth for making hot pressed fiber reinforced carbide-graphite composite, 2:57164 (LA-UR—77-1261)
Hollen, R.M., Evaluation of the LASL automated spectrophotometer for uranium determination at submilligram levels, 2:57203 (LA—6867)
Hollenack, W.R., *See* Lewis, H.E., 2:55625
Hollenberg, G.W., Measurement of tritium retention in fast-neutron-irradiated boron carbide, 2:56725
Hollister, C.D., Oceanographic processes and the ultimate disposal of high-level radioactive waste, 2:55930
Holman, R.R., Conceptual approach to laser fusion hybrid reactor, 2:57778
Holmes, J.M., Hydrocarbonization process evaluation report. Volume II. Evaluation of process feasibility, 2:55558 (ORNL—5213)
See Salmon, R., 2:55617
Holmes, J.R., Incineration of domestic refuse: refuse into energy at Sheffield, 2:56248
Holmes, J.T., Sodium technology at EBR-II, 2:56479 (CONF-760503—P1, pp 12-21)
Holmstrom, H.L.O., *See* White, J.R., 2:56761
Holshouser, D.F., *See* Hittle, D.C., 2:56105
Holte, H., *See* Gerard, A., 2:57360
Honda, N., *See* Goto, T., 2:56572
Honma, K., Behavior of inner surface oxidation of the zircaloy cladding tube in a loss-of-coolant accident, 2:56783 (JAERI-M—6602)
Honma, T., *See* Akita, J., 2:56699
Hook, N.B., *See* Woodhall, C.B., 2:55890
Hooks, H.W., *See* Lewis, H.E., 2:55625
Hooper, F.C., Design of a solar heating system using seasonal heat storage, 2:56107
Hoornstra, J., *See* Bloemen, H.A., 2:56536
Hopkins, D.R., Transportation regulatory revisions, 2:55887
Hopkins, G.R., Plasma impurity radiation from iron and silicon, 2:57647
Hopkins, R.H., Silicon Materials Task of the Low Cost Solar Array Project (Phase II). Sixth quarterly report, 1 January 1977—March 31, 1977, 2:56032 (ERDA/JPL/954331—77/2)
Hopper, D.G., *See* Wahl, A.C., 2:57501
Hori, M., *See* Sato, M., 2:56509
Horl, T., *See* Nishimaki, K., 2:56691
Horikawa, T., *See* Goto, T., 2:56572
Horiya, T., *See* Kanazawa, S., 2:57136
Horner, M., Cylindrical prestressed concrete tank for a nuclear power plant, 2:56432
Hornyik, K., Interaction between utilites and the university, 2:56626

Horton, W. Jr., Initial value problem with non-Hermitian radial mode equations, 2:57665
See Hitchcock, D.A., 2:57670
Horvath, L., Deviated conductor driving system, 2:55758
Hosea, J., Electron cyclotron emission from the Princeton Large Tokamak, 2:57685
Hoskins, R.A., Energy and cost analysis of residential water heaters, 2:57014 (ORNL/CON—10)
Hoskins, R.E., Plutonium recycle's relation to the future of nuclear power, 2:56937
Hosokawa, T., Fuel assembly in a reactor, 2:56717
Nuclear fuel pellets, 2:56718
Hotchkiss, R.C., Geothermal resources in this country, 2:56175
Houser, T., Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, 11 September—10 December 1976, 2:55723 (FE—2018-6)
Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, December 11, 1976—March 10, 1977, 2:55724 (FE—2018-7)
Houston, M.D., *See* Meyer, R.O., 2:56722
Hovel, H.J., Solar cells for terrestrial applications, 2:56060
Hovingh, J., First-wall costs of an ion-beam fusion reactor, 2:57794
Hovland, H., *See* Gnirk, P.F., 2:55908
Howard, P.A., Detection of a partial blockage in a heterogeneous core, 2:56476 (ANL-CT—77-30)
Howerton, M., *See* Hall, C.A., 2:56151
Howland, J.W., Thermal insulating fluid, 2:55767
Hsieh, S.Y., Conceptual demountable TF magnet design for UWMAK-II fusion reactor, 2:57735
See Powell, J.R., 2:57715
Hsieh, T., Some probabilistic aspects of the seismic risk of nuclear reactors, 2:56789 (PB—265020)
Hsu, M., Self-initialization of the RELAP4 momentum equation, 2:56811
Hsu, T.R., Analysis of residual stresses/strains in pressure vessels due to cyclic thermomechanical loads, 2:56281
Hu, C., Analysis of silicon solar cells with stripe geometry junctions, 2:56049
Huang, T.C., Aerosol attenuation in leakage paths, 2:56819
Sensitivity of radiological consequences to variations in aerosol parameters, 2:56820
Huber, C.C., INSITE: information on nuclear sites data system, 2:56746
Huber, F., Investigations into the self-welding behavior of metallic materials exposed to sodium, 2:56499 (CONF-760503—P1, pp 177-186)
Huber, O., *See* Riedel, H., 2:57367
Huc, A.Y., Geochemical provinces revealed in Toarcian oil shales in the eastern Paris Basin. Analysis of the soluble organic fraction, 2:55830
Huchet, R., Contribution of coal to the energy supply of France, 2:56964
Huddle, R.A.U., Metallurgical problems of the he-to-he heat exchanger for advanced htr's, 2:56455
Hudis, M., Current limiting fuse study. Final report, 2:56349 (EPRI-EL—453(6-77))
Hudson, M., *See* Brown, W.M., 2:55608
Hudson, R.G., *See* Chin, J., 2:57155
Huff, J.E., Toxicology Information Response Center literature search index, June 1976—May 1977. III. 2601—3100, 2:57445 (ORNL/TIRC—77/6)
See Ulrikson, G.U., 2:57460
Hughes, R., Removal of contaminants from industrial gaseous effluents, 2:55654
Hulet, E.K., Search for superheavy elements in the bombardment of ^{248}Cm with ^{48}Ca, 2:57601
Humphrey, A.E., *See* Fischer, D.D., 2:55562
Hunt, J.T., *See* Glaze, J.A., 2:57286
Hunt, L.P., Solar silicon via improved and expanded metallurgical silicon technology. Quarterly report, No. 3, 2:56041 (ERDA/JPL/954559—77/1)
Hunter, T.O., *See* Abdel-Khalik, S.I., 2:57782
Huntington, J., *See* Mayo, F.R., 2:55637
Hurdis, D.A., *See* Bender, F.E., 2:56092
Hurt, R.F., *See* Pekarsky, M.I., 2:56815
Huschka, H., Fuel particles with coatings without property gradients, 2:55869
Husseiny, A.A., *See* Dei, D.A., 2:57754
Hustrulid, W., Study to determine research and development needs in western mining. Final report, 2:57281 (PB—264429)
Hutchinson, D.P., ORNL plasma diagnostic research, 2:57635 (CONF-770434—5)
Huxtable, D.D., Thermal energy storage by the sulfuric acid—water system, 2:56162
Hwang, I.T., Comparison of experimental data with COBRA-3M prediction for an LMFBR loss-of-piping-integrity transient, 2:56856
Hwang, W.G., Economic feasibility of a fusion-based energy storage system, 2:57741
Hyman, L.G., *See* Barish, S.J., 2:57564

I

Ibatulina, K.A., *See* Terekhova, A.I., 2:57041
Igenbergs, E., Energy storage during orbital and interplanetary missions, 2:56883 (AED-CONF—76-377-002)
Ignatius, R., *See* Goodman, N.B., 2:56074
Ignatov, V.A., *See* Paton, B.E., 2:57097
Ignatyuk, A.V., Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction, 2:57600
Ikeda, H., Lithium ion conductive electrolyte composition, 2:56902 (SAND—77-6009)
Ikeda, M., Fuel assembly, 2:56716
Ikemoto, Y., *See* Tunenari, T., 2:57259
Ikkai, T., *See* Kihara, H., 2:56680
Ikov, N.I., *See* Angelov, N., 2:57571
Il'inskii, A.I., *See* Zakhodov, R.A., 2:56131
Il'kevich, Z.A., *See* Savin, V.I., 2:57009
Imarisio, G., *See* Coen-Porisini, F., 2:55975
Imaza, A., *See* Nakamura, K., 2:56558
Imshennik, V.S., Compton-radiation gas dynamics, 2:57620 (UCRL-Trans—11236)
Light curves of type II supernovae, 2:57480
Inagaki, M., *See* Kihara, H., 2:56680
Ingle, R.W., *See* Difilippo, F.C., 2:57606
Ingle, W.M., Semiconductor grade, solar silicon purification project. Technical quarterly report No. 5, January 1, 1977—March 31, 1977, 2:56038 (ERDA/JPL/954442—77/2)
Inogamova, T.Y., *See* Angelov, N., 2:57570, 2:57571
Inopin, E.V., Hartree-Fock method with an effective interaction that depends on the density and on the self-consistency condition, 2:57616
See Gonchar, V.Y., 2:57613, 2:57615
Inoue, A., *See* Bankoff, S.G., 2:56532
Ioffe, V.Yu., *See* Arkad'ev, B.A., 2:56664
Iorii, J.A., *See* Schreiber, R.E., 2:56409
Iovlev, V.I., *See* Budzhenko, A.I., 2:57055
Ippolito, M., Use of coal in power plants, 2:56978
Iroshnikov, G.S., Elastic πN scattering in a dual model with the correct spectrum of baryon resonances, 2:57581
IrresberGer, H., Shield support practice in German coal mining, 2:55691
Isbell, W.M., Response of porous beryllium to static and dynamic loading, 2:57118 (UCRL—79712)
Ishibashi, E., *See* Uematsu, K., 2:56578
Ishigami, T., Factors influencing crystalline form of calcareous sinters, 2:56213
Ishiguro, T., *See* Kunitake, H., 2:56385
Ishii, M., Multichannel cladding relocation model for loss-of-flow accidents in LMFBRs, 2:56853
Ishii, T., Determination of trace elements in hot spring water by anode stripping voltametry, 2:56211
Isler, R.C., Measurements of the concentrations of impurities in tokamaks, 2:57720
Ismanzhanov, A., *See* Zakhidov, R.A., 2:56124
Isozaki, T., *See* Miyazono, S., 2:56387
Itkis, M.G., *See* Ignatyuk, A.V., 2:57600
Ito, A., Reactor, 2:56574
Reactor, 2:56575
Ito, H., *See* Hiraga, S., 2:56188
Ito, S., *See* Maki, K., 2:56720
Itoh, T., *See* Matsumura, M., 2:56556
Ivanenko, V.D., Informational threshold of sensitivity of radiation detectors, 2:57333
Ivanov, B.M., *See* Khodot, V.V., 2:55736
Ivanov, N.A., Number of Frenkel defects in germanium irradiated with high-energy gamma rays, 2:57153
Ivanov, P.V., *See* Budzhenko, A.I., 2:57055
Ivanov, V.A., Selection of a rational program of control of high pressure condensing steam turbine power plants, 2:56299
Thermodynamic analysis of the work of heat-and-power turbine plants with sliding initial steam pressure, 2:56235
Ivanov, Yu.V., *See* Delyagin, G.N., 2:57322
Ivanovskaya, I.A., *See* Angelov, N., 2:57570, 2:57571
Ivchenko, V.M., Hydrodynamic theory of supercavitating pumps or hydroturbines, 2:56007
Iverovskii, E.N., Selection of the shape of cross-section of mine workings driven by combines, 2:55692
Iwai, J., *See* Ohanian, E.V., 2:57427
Iwata, S., *See* Nishimaki, K., 2:56691

J

Jackim, E., Effects of environmental factors on radiocadmium uptake by four species of marine bivalves, 2:57447
Jackman, A.H., Delayed hydrogen cracking of zirconium alloy pressure tubes, 2:56470
Jackson, D.D., *See* Hollen, R.M., 2:57203
Jackson, J., *See* Cohn, S., 2:57013
Jackson, J.F., *See* Bott, T.F., 2:56847
Jackson, R.L., Uranium/water vapor reactions in gaseous atmospheres, 2:57242 (Y—2078)
Jackson, R.R., Purex process operation and performance, 1970 Thoria Campaign, 2:55879 (ARH—2127)
Jackson, W.A., Nitrate uptake by dark-grown corn seedlings. Some characteristics of apparent induction, 2:57419

See Morgan, M.A., 2:57418
Jacobs, R.T., Remote maintenance equipment for the new waste calcining facility, 2:55903
Jaffe, F., Utilization of geothermal energy for heating of Swiss cities, 2:56174
Jahns, G.L., Observation of tokamak plasmas with an array of pin diode detectors, 2:57636 (CONF-770434—6)
James, E., *See* Kury, J.W., 2:57349
Jameson, A., Numerical calculation of the transonic flow past a swept wing, 2:57251 (COO—3077-140)
Jancso, G., Early scaling and exotic channels in πN interactions in the fragmentation regions, 2:57582
Jardine, D.M., Systems approach to solar heating and cooling systems, 2:56096 (CONF-770359—1)
Jasch, E., *See* Schlaich, J., 2:56449
Jassby, D.L., Fueling of toroidal plasmas by ripple-assisted injection of energetic particles, 2:57751
Jeffs, E., Germany plans process heat schemes for HTGR, 2:56609
Mergers create single French sources for nuclear, fossil, hydro plants, 2:56977
Jenkins, J.P., *See* Hill, J.E., 2:56106
Jenkins, L.H., *See* Behrisch, R., 2:57494
Jenkins, N., Underground gasification offers clean safe route to coal energy, 2:56962
Jenkins, R.W., *See* Williamson, T.G., 2:57339
Jennings, C.D., Vertical distribution of ^{55}Fe in the ocean, 2:57399 (RLO—2231-T1-9)
Jennison, D.R., Significant differences between Hartree-Fock and local-exchange energy bands for TiO, 2:57158
Jensen, C.M., *See* Macbeth, P.J., 2:55940
Jensen, W.P., *See* Cox, N.D., 2:57036
Jeschar, R., *See* Scholz, R., 2:57317
Jessop, A.M., World heat flow data collection, 1975, 2:56207
Jester, W.A., Ge(Li) system for the monitoring of low level radioactive gases, 2:57332
Jett, J.H., Mathematical analysis of DNA histograms from asynchronous and synchronous cell populations, 2:57417 (LA-UR—77-992)
Jewell, W.S., Estimates and sampling schemes for the instrumentation of accountability systems, 2:55902 (UCRL—13733-1)
Johanson, E.E., Status of wind energy conversion systems (WECS) for electric utility power generation, 2:56220
Johnson, B.M., *See* Allemann, R.T., 2:56345
See Braun, D.J., 2:56241
See Zaloudek, F.R., 2:56236
Johnson, C.E., *See* Fischer, A.K., 2:57497
Johnson, J.J., MODSAP: a modified version of the program SAP IV for the static and dynamic response of linear and localized nonlinear structures, 2:57808 (GA-A—14405)
Johnson, J.L., *See* Chance, M.S., 2:57663
Johnson, J.P., Fragmentation of aliphatic chlorocarbons under low-energy (< or approx. =10 eV) electron impact, 2:57512
Johnson, R.G., *See* Sharp, R.D., 2:57491
Johnson, R.M., Battery powered mail vans, 2:57070
Johnson, R.N., Development of low friction materials for LMFBR components, 2:56492 (CONF-760503—P1, pp 122-130)
See Hoffman, N.J., 2:56498
See Whitlow, G.A., 2:56494
Johnson, W., *See* Auer, I.P., 2:57567
See Conn, R.W., 2:57791
Johnson, W.F., *See* Mrochek, J.E., 2:57201
Jolles, M., *See* Smith, C.W., 2:57256
Jolley, R.L., Chloro-organics in surface water sources for potable water, 2:57388 (CONF-770552—1)
Jonah, C.D., Reaction of e/sub aq/$^-$ + H_3O^+. Concentration effects of acid or salts, 2:57239
Jonckheere, A., *See* Auer, I.P., 2:57567
Jones, E.M., *See* Sandford, M.T. II, 2:57478
Jones, K.W., *See* Griffin, P.M., 2:57219
Jones, M.C., Helium research in support of superconducting power transmission. Annual report, July 1975—September 1976, 2:56360 (CONS/3800—1)
Jones, O.C., *See* El-Genk, M., 2:56850
Jones, T.A., HI-CAP high-capacity fuel rack design, 2:56656
Jones, T.B., Polarized particle levitation in hexapole field, 2:57770 (UCRL—13735-2)
Jones, T.E., *See* Molz, F.J., 2:56166
Jonzen, M.R., Energetics assessment of the potential of the fusion-fission hybrid reactor system, 2:57709
Joos, D.W., Evaluation of human errors in commercial light-water reactors, 2:56859
Jordan, H., *See* Gieseke, J.A., 2:56768
Jorgenson, D.W., *See* Behling, D.J. Jr., 2:56954
Jorgenson, W.E., *See* Saxton, H.J., 2:57208
Jouris, G.M., *See* Bamford, W.H., 2:56677
Joy, D.S., *See* Holmes, J.M., 2:55558
See Salmon, R., 2:55617
Joyce, M.E., State of the art: wastewater management in the beverage industry, 2:57047 (EPA—600/2-77-048)
Julien, M., Alloy 800 for liquid-metal fast breeder reactor steam generators, 2:56565
Jung, K., *See* Paul, D., 2:57527

K

Kaderabek, E., *See* Cech, B., 2:55884
Kahn, H., *See* Brown, W.M., 2:55608
Kahrs, J.R., *See* Flagella, P.N., 2:56521
Kakabaev, A., *See* Rakhmanov, A., 2:56101
Kakhramanov, N.T., *See* Buniyat-Zade, A.A., 2:57172
Kaldenbach, R.J., *See* Breiner, S., 2:55859
Kalinina, V.P., Data base for analyzing results of oil and gas exploration, 2:55748
Kalinovskii, A.N., *See* Abramov, V.V., 2:57565
Kallio, G.A., *See* Jones, T.B., 2:57770
Kalliokoski, J., Uranium, thorium, and potassium content of Precambrian rocks, Upper Peninsula of Michigan and northern Wisconsin. Supplement to GJBX—48(76). Uranium and thorium occurrences in Precambrian rocks, Upper Penninsula of Michigan and northern Wisconsin, with thoughts on other possible settings, 2:57196 (GJBX—43(77))
Kalmykov, V.A., *See* Filippov, G.A., 2:56286
Kaloshin, A.E., *See* Vall, A.N., 2:57580
Kalwa, G., *See* van Heek, K.H., 2:55593
Kamada, K., Actual service life and bench cycle life of lead—acid battery for electric vehicle use, 2:56900
Kamada, N., Intake air heating device for use in internal combustion engine, 2:57050
Kameari, A., *See* Ninomiya, H., 2:57737
Kamimura, K., *See* Uematsu, K., 2:56578
Kaminski, D.J., *See* Spier, E.M., 2:56411
Kaminskii, L.V., Statistical analysis of patents for determination of the world level of development of coal pulverization equipment at steam power plants, 2:55720
See Landa, G.R., 2:56324
Kaminsky, M., *See* Behrisch, R., 2:57494
See Cafasso, F., 2:57789
Kaminsky, M.S., Method and means of reducing erosion of components of plasma devices exposed to helium and hydrogen isotope radiation, 2:57803
Kamiya, K., Method and apparatus for failed fuel detection, 2:56402
Kamiya, M., Stratified combustion type engine, 2:57080
Kammash, T., *See* Campbell, R.B., 2:57780
See Galbraith, D.L., 2:57633
See Gilligan, J.G., 2:57649
Kamo, Y., *See* Ikeda, M., 2:56716
Kanarek, T., *See* Angelov, N., 2:57570, 2:57571
Kanazawa, S., 2¼Cr—1Mo steel plate with improved temper embrittlement characteristics, 2:57136
Kaneko, H., *See* Uematsu, K., 2:56578
Kaneko, Y., *See* Akino, F., 2:56649
Kanin, V.A., Role of porous and fissiparous structure of coal in creating burst hazard situations and in mechanisms of sudden coal and gas bursts, 2:55737
Kannatey-Asibu, E. Jr., Kinetics of formation of the A-15 phase in the Nb—Al—Ge system, 2:57105 (LBL—6266)
Kanoh, S., Friction and wear behavior of Colmonoy and Stellite alloys in sodium environment, 2:56496 (CONF-760503—P1, pp 153-159)
Kanroji, Y., Calcium chloride springs of sea water origin in Toi Hot Spring, 2:56191
Kanter, M.A., Teaching project management as part of international technology, 2:56623
Kantserov, V.A., *See* Abramov, V.V., 2:57565
Kapel'son, L.M., Comparative tests of a TP-100 boiler with closed-loop and open-loop systems of p.f. preparation when burning Lvov-Volynian pit coal, 2:56312
Kapelyushnikov, V.M., *See* Bazarov, B.A., 2:56129
Kaplan, M.P., *See* Ol'khovskii, G.G., 2:56288
Kaplan, S., *See* Potter, T., 2:57373
Kapur, V.K., Novel duplex vapor-electrochemical method for silicon solar cells. Quarterly progress report No. 4, November 1, 1976—January 31, 1977, 2:56039 (ERDA/JPL/954471—77/1)
Kapuscinski, T., *See* Duzniak, S., 2:55663
Karataev, A.P., *See* Semenov, B.N., 2:57021
Karetnikov, V.N., *See* Popov, V.L., 2:55702
Karlov, N.V., Generation of nanosecond pulses in high-pressure CO_2 lasers, 2:57294
Population inversion for $10^00—01^10$ and $02^00—01^10$ transitions of the CO_2 molecule with gasdynamic cooling, 2:57292
Karo, A.M., *See* Hardy, J.R., 2:57623
Karow, H.U., *See* Bober, M., 2:56774
Karpin, E.B., Experience of vibrational detuning of blading, 2:56274
Karpov, G.G., *See* Belyaev, V.I., 2:56365
Kartzmark, R., *See* MacDonald, J.M., 2:55771
Karzmar, R.C., *See* Grimm, E.A., 2:56370
Kaser, A., *See* Herberg, G., 2:56559
Kasper, K., Graphite reflector in HTR with pebble bed and OTTO-fueling, 2:56445
See Badur, A., 2:56804
See Kroeger, W., 2:56809
Kasprzak, K.S., Mechanisms of dissolution of nickel subsulfide in rat serum, 2:57455

Kastenberg, W.E., *See* Badham, V., 2:57745
See Ferrell, W.L., 2:57744
See Frank, M.V., 2:56855
See McKone, T.E., 2:57763
See Okrent, D., 2:57761
See Reilly, J.T., 2:56845
See Rubin, M.P., 2:57371
Katsuno, Y., *See* Ishii, T., 2:56211
Katsuragi, S., *See* Suzuki, T., 2:56567
Katz, E.L., *See* Watson, M., 2:56081
Katz, J.J., Isotope chemistry and biology, 2:57438
Kauffman, G.F., Analytical capability of the uranium hexafluoride mass spectrometer, 2:57202 (GAT-T—2657)
Kauffman, K.W., Thermal energy storage with saturated aqueous solutions, 2:56165
Kaufman, A.N., *See* Cary, J.R., 2:57684
Kaufman, H.R., Industrial ion source technology. Annual report, 2:57493 (N—77—16248)
Kaufman, L.I., *See* Zel'vyanskii, A.S., 2:55707
Kawahara, A., *See* Saito, S., 2:56715
Kawai, T., *See* Kiguchi, T., 2:56698
Kawamura, H., Transient heat transfer in turbulent flow with time-dependent heat input, 2:56638 (JAERI-M—6597)
Kawasaki, S., *See* Honma, K., 2:56783
Kaynor, E.R., Connecticut river water resource decision-making. Completion report, 2:57394 (PB—265390)
Kazimi, M.S., Limits of stability of internally heated boiling pools, 2:56842
Kazmerski, L.L., $CuInSe_2$/CdS thin film solar cells, 2:56073
Keer, L.M., *See* Weertman, J., 2:56204
Keeton, A.R., Sodium and steam leak simulation studies for fluidized bed steam generators, 2:56510 (CONF-760503—P1, pp 256-262)
Kehler, W.F., *See* Spaelti, E., 2:56456
Keilman, J.C., *See* Saxton, H.J., 2:57208
Kelin, G.E., *See* Arkad'ev, B.A., 2:56664
Keller, T.W., Queueing network models of computer systems with limited parallelism in subnetworks, 2:57811 (LA-UR—77-894)
Keller, V.D., *See* Rybalko, V.K., 2:57320
Kelley, R.E., Predicting the effect of geothermal emissions on the temperature and relative humidity in the Imperial Valley of California, 2:56197
Kelly, K.A., Digital modeling of a zone plate, gamma-ray imaging system, 2:57424
Kempter, V., Optical emission in slow atomic collisions, 2:57534
Kendall, G.H., Importance of reservoir description in evaluating in-situ recovery methods for Cold Lake heavy oil. I. Reservoir description, 2:55842
Kennard, L., *See* Larsen, J.W., 2:55631
Kennedy, E.J., *See* Baker, J.P., 2:57315
Kennedy, M.F., First-generation model to predict particle-size distributions for condensed UO_2 vapor, 2:56821
Kent, G., *See* Franz, S., 2:56047
Kent, ı., Reflection coefficient for a back-surface glass mirror, 2:56148
Kerchner, H.R., Low-temperature irradiation of niobium with 15-MeV neutrons, 2:57141 (CONF-770649—1)
Kerimov, Z.G., Determination of the front of propagation of the permafrost thawing zone around producing wells, 2:55766
Kern, R.C., *See* Hsu, M., 2:56811
Kern, W., *See* Stein, N.A., 2:57566
Kerner, W., *See* Chance, M.S., 2:57663
Kerr Del Grande, N., Method for identifying anomalous terrestrial heat flows, 2:56181
Kertsher, F., *See* Akkerman, G., 2:56394
Kesper, B., Frictional pressure drop in adiabatic high velocity two-phase flow, 2:57304
Kessler, J., Recent advances in polarized-electron experiments, 2:57521
Kessler, T.C., Best-judgment analysis of emergency core cooling system performance, 2:56798
Kevan, L., *See* Rice, S.A., 2:57238
Khabanova, E.M., *See* Kolyada, G.I., 2:56229
Khairiddinov, B., Solar glass house with subsoil heat accumulator, 2:56104
Khakimov, K.K., *See* Akilov, Yu.Z., 2:57830
Khampel, R., *See* Akkerman, G., 2:56394
Khandurdyev, A., *See* Rakhmanov, A., 2:56101
Khentshel, G., *See* Akkerman, G., 2:56394
Khizhnyakov, A.V., *See* Glushko, V.V., 2:55747
Khlyustova, T.M., *See* Pis'man, B.Ya., 2:56681
Khmara, O.M., *See* Ryzhkov, S.V., 2:57301
Khodot, V.V., Sudden coal and gas bursts. ways to solve the problem, 2:55736
Khodzhaev, A.Sh., *See* Zakhidov, R.A., 2:56130
Khokhlova, V.L., Relative abundances of elements in main-sequence stars, and nucleosynthesis, 2:57479
See Polosukhina, N.S., 2:57481
Khrilev, L.S., *See* Savin, V.I., 2:57009
Khristich, L.M., *See* Parshin, A.A., 2:56310, 2:56321
Khristov, K.Y., *See* Angelov, N., 2:57571
Khristova, E.K., Effects of neutral currents in the process of e^+e^- annihilation into a baryon-antibaryon pair, 2:57575
Kidman, R.B., Energy flow patterns for 1975, 2:56982 (LA—6770)
Kiener, K., Process and apparatus for the production of combustible gas, 2:55992
Kiguchi, T., Apparatus for measuring neutron flux distribution in a reactor, 2:56698
See Motoda, H., 2:56736
Kihara, H., Properties of explosive-welded Monel-clad steels, 2:56680
Kikutake, T., *See* Kunitake, H., 2:56385
Kim, S.H., Stark effect in three-dimensional stochastic electric fields and a static magnetic field of a helium plasma, 2:57638
Kim, V.P., Regional conditions and the possibility of application of low temperature solar heaters in Yakutian mines, 2:56102
Kim, Y.T., Flow-induced bending of rectangular plates, 2:56758
King, J.H.H., *See* Carter, W.S., 2:56145
King, S.B., Investigation of aromatic fractions from coal tar produced by an underground coal gasification test, 2:55561 (CONF-770510—7)
See Fischer, D.D., 2:55562
King, W., *See* Bonewitz, R.A., 2:56144
See Powers, J.H., 2:56139
Kingery, W.D., Needs and opportunities for ceramic science and technology, 2:57032 (COO—2390-15)
Kini, K.A., *See* Biswas, S.C., 2:55549
Kinsey, V.E., Biochemical studies on the ocular lens in relation to cataractogenesis. Progress report, July 1, 1975—May 31, 1977, 2:57434 (COO—2012-27)
Kireev, G.A., *See* Margulova, T.Kh., 2:56682
Kirichenko, Y.V., *See* Gonchar, V.Y., 2:57615
Kirillin, V.A., Some results of investigations with the U-25 pilot plant to bring it up to design parameters, 2:56990
Kirillov, I.I., Boosting of power gas turbine installations by water injection into the high pressure tract, 2:56332
Investigation of a turboseparator with a freely rotating impeller, 2:56272
Kirillov, V.V., *See* Zalkind, V.I., 2:56995
Kirillov-Ugryumov, V.G., *See* Abramov, V.V., 2:57565
See Borog, V.V., 2:57596
Kirkpatrick, A.R., Integral glass encapsulation for solar arrays. Quarterly progress report No. 4, May 1977, 2:56040 (ERDA/JPL/954521—77/2)
Low energy production processes in manufacturing of silicon solar cells, 2:56065
Kirshen, N., *See* Mayo, F.R., 2:55637
Kiselev, A.V., *See* Abramov, V.V., 2:57565
Kiselev, G.P., Operation of the K-200-130 turbine in motor regime conditions, 2:56253
Kiselev, V.I., *See* Kopylov, I.P., 2:56309
Kishi, T., *See* Wirsching, J.E., 2:57823
Kissane, R.J., *See* Crissman, H.A., 2:57416
Kitadate, K., *See* Akino, F., 2:56649
Kitagawa, M., Cyclic stress strain behavior of four nuclear pressure vessel materials, 2:56676
Kitano, K., *See* Kobayashi, H., 2:57217
Klabunde, C.E., *See* Kerchner, H.R., 2:57141
Klabunde, K.J., *See* Woolsey, N.F., 2:55620
Kladnitskaya, E.N., *See* Angelov, N., 2:57570, 2:57571
Klamut, C.J., *See* Luhman, T., 2:57107
Kleber, M., *See* Betz, H.D., 2:57543
Kleefeldt, K.W., Experimental investigations of the frictional and wear behavior of tungsten carbide cermet ball bearings under axial load in liquid sodium, 2:56495 (CONF-760503—P1, pp 145-152)
Klemenov, N.G., Refinement of the regime of chemical cleaning of k-300-240 KHTZ turbines under load, 2:56254
Klein, P.D., Argonne Bioanalytical Center: a resource for collaborative biomedical applications of stable isotopes, 2:57407 (CONF-761234—3)
Kleinman, L.I., *See* Wolfsberg, M., 2:57223
Kleinpoppen, H., Analysis of inelastic electron—photon coincidence experiments, 2:57546
Klemperer, W., *See* Herbst, E., 2:57487
Klenin, M.A., *See* Bari, R.A., 2:56828
Klepper, O.H., Studies of a small PWR for onsite industrial power, 2:56608 (CONF-770403—15)
Kleshchevnikov, V.P., *See* Buglaev, V.T., 2:56301
Klesment, I., Composition of heavy shale oil...characterization of thermolysis products of the acid part of the shale, 2:55847
Klimovskikh, E.S., *See* Vinogradnik, M.V., 2:56277
Kline, R.V., *See* Auer, I.P., 2:57567
Klovan, J.E., *See* Embry, A., 2:55750
Klueh, R.L., Creep and rupture behavior of a bainitic (normalized and tempered) 2 1/4 Cr—1 Mo steel, 2:57116 (ORNL—5273)
Kmetko, E.A., *See* Hill, H.H., 2:57218
Knapp, V., Utilization of geothermal energy in dry rock masses, 2:56171
Knecht, O., Activities of the committee 'Kernreaktorregelung' (nuclear reactor control) in the past few years and future projects, 2:56734
Knecht, P.D., Power plant productivity. Analysis report, 2:56591 (PB—264467)
Productivity improvement action plan, 2:56592 (PB—264468)
Kneese, A.V., Benefit-cost analysis in the nuclear fuel cycle, 2:56598
Knoedler, D., *See* Lettau, H., 2:56467

Knoll, G.F., Computer-based data acquisition system for a multistation teaching laboratory, 2:56619
Knude, J.K., Extinction towards the South Galactic Pole determined from reddening of A and F stars, 2:57486
Knudsen, I.E., Production of uranium dioxide, 2:55864
Knutsen, C.A., *See* Bloomster, C.H., 2:56194
Koba, A., Leakage detecting apparatus in an atomic power plant, 2:56703
Koban, J., Neutron flux calculations with regard to radiation damage, explained for the geometry of a KWU 1300-MWe PWR facility, 2:56416
Kobatake, K., *See* Tunenari, T., 2:57259
Kobayashi, A.S., Corner crack at a nozzle, 2:56672
Surface flaw in a pressurised and thermally-shocked hollow cylinder, 2:56658
See Emery, A.F., 2:56661
See Love, W.J., 2:56374
Kobayashi, H., Mechanism of nitrous acid decomposition, 2:57217 (ORNL-tr—4405)
Kobayashi, R., Phase equilibria in coal hydrogenation systems. Quarterly report, April 1977—June 1977, 2:55557 (FE—2334-5)
Kobayashi, T., *See* Hiraga, S., 2:56188
Kobayashi, Y., *See* Uchikawa, T., 2:56689
Koch, H., Exhaust gas emissions of Brown Boveri gas turbines, 2:56347
Koch, L., Elaboration of methods for burn-up determinations of fast reactor fuel, 2:56570
Kochetkov, O.P., Investigation of stability and breakup of particles of a material during fusion in a gas suspension, 2:57321
Kochetov, I.V., *See* Karlov, N.V., 2:57294
Kodaira, T., *See* Miyazono, S., 2:56387
Koehler, L., Device for continuous electrolytic polishing of rod-shaped work pieces of zirconium alloys, 2:56712
Koehler, P.F.M., *See* Auer, I.P., 2:57567
Koelle, A.R., *See* Bobbett, R.E., 2:57340
Koenig, D.R., *See* Kidman, R.B., 2:56982
Koenne, W., Various methods of studying the reliability of power systems, 2:56351
Koepke, W.E., *See* Fraser, D.B., 2:56932
Koester, J.K., *See* Eustis, R.H., 2:56996
Koethe, H.K., Electrochemical power sources in ocean engineering, 2:56897 (AED-CONF—76-203-006)
Koetzle, T.F., Neutron diffraction studies of tetrahedral cluster transition metal hydride complexes: $HFeCo_3(CO)_9(P(OCH_3)_3)_3$ and $H_3Ni_4(C_5H_5)_4$, 2:57209 (BNL—22982)
Kohn, H.W., Spent nuclear fuel: prospects for output, storage and reprocessing, 2:56373
Kohzuma, N., *See* Hiraga, S., 2:56188
Kolar, J., Ultimate energy requirements for small consumers, 2:56953
Kolesnichenko, Ya.I., *See* Belikov, V.S., 2:57673
Kollerov, L.K., *See* D'yachenko, N.Kh., 2:57324
Kollie, T.G., *See* Roberts, M.J., 2:57342
Koloc, P.M., Method and apparatus for generating and utilizing a compound plasma configuration, 2:57655
Kolpishon, E.Yu., *See* Vasil'chenko, G.S., 2:56330
Kolster, B.H., Corrosion, transport, and deposition of stainless steel in liquid sodium, 2:56522 (CONF-760503—P1, pp 368-377)
Koltun, M.M., Utilization of transparent heat reflecting coatings in solar energy converters, 2:56055
Koltunov, V.S., Kinetics of the reaction between hydrazine and nitric acid catalyzed by molybdenum(VI), 2:55996
Kolyada, G.I., Results and problems of the new system of planning, financing and economic stimulation of research for development of new power engineering equipment, 2:56229
Kolybasov, V.M., Contributions to the theory of isobar knockout from a deuteron, 2:57585
Komarek, K.L., *See* Konvicka, H.R., 2:56526
Komarek, P., Applications of superconducting magnets to energy with particular emphasis on fusion power, 2:57740
Komarov, S.R., *See* Ivanov, N.A., 2:57153
Komarov, V.N., *See* Volchenok, V.I., 2:57295
Komkova, G.I., *See* Pis'man, B.Ya., 2:56681
Konashev, S.I., *See* Reznik, V.I., 2:56334
Kondo, S., *See* Uchikawa, T., 2:56689
Kondo, T., *See* Hasegawa, M., 2:56540
Konev, Y.B., *See* Karlov, N.V., 2:57294
Konishi, T., *See* Maki, K., 2:56720
Konopka, A., Alternative forms of energy transmission from OTEC plants, 2:56089 (CONF-770331—5)
See Yudow, B., 2:56091
Kontorovich, A.E., Oil and gas geological zoning of the Siberian Platform, 2:55741
Konvicka, H.R., Thermodynamic and diffusion studies on corrosion of austenitic stainless steel in liquid sodium, 2:56526 (CONF-760503—P1, pp 400-406)
Kopellovich, A.M., *See* Lokshin, V.A., 2:56315
See Zubov, I.V., 2:56291
Kopetskii, C.V., *See* Vinnikov, L.Y., 2:57162
Koponen, B.L., Reactivity enhancement in transportation and storage arrays due to fissile material density reductions, 2:57274
Koppel', E.I., *See* Viksman, A.S., 2:57058
Koppel, L.N., MOS solid-state detector arrays for x-ray imaging, 2:57336 (UCRL—79376)
Kopylov, G.I., *See* Angelov, N., 2:57571
Kopylov, I.P., Computer-aided investigation of dc generators, 2:56309
Korens, N., Low-Btu gas from coal has many potential markets, 2:56966
Kornfel'd, V.N., *See* Andreev, V.A., 2:57042
Korolenko, Yu.A., Motion of an evaporating drop in superheated steam flow, 2:57303
Korotkevich, M.A., Determination of the annual economic effect of automation of control of an electric utility enterprise, 2:56921
Korsunov, V.M., *See* Parshin, A.A., 2:56273
Korzh, P.I., *See* Ol'khovskii, G.G., 2:56288
Korzhov, E.N., *See* Kleimenov, N.G., 2:56254
Koshelev, P.F., *See* Vasil'chenko, G.S., 2:56330
Koskinas, G.H., *See* Campbell, J.H., 2:55835, 2:55836
Kosmach, V.F., *See* Ivanov, N.A., 2:57153
Kostin, A.K., Method of calculation of heat transfer from a working medium to the walls of the combustion chamber of a diesel engine, 2:57328
Kostoff, R.N., Economic analysis of commercial fusion power, 2:57699
Kosyak, A.F., *See* Bogdanov, B.I., 2:57054
Kosyak, Yu.F., Problems of improving steam turbine seals, 2:56252
Kotov, Yu.V., *See* Kirillov, I.I., 2:56332
Kottowski, H.M., Application of boiling liquid metals in industrial processes, 2:56607 (CONF-760503—P1, pp 427-430)
Kotyk, V.A., *See* Glushko, V.V., 2:55747
Koutsandreas, J.D., *See* Melfi, S.H., 2:57366
Kovacik, W.P., *See* Holman, R.R., 2:57778
Kovacs, P., *See* Zubler, R., 2:56259
Koval'skii, V.Ya., *See* Bordina, N.M., 2:56054
Kovalev, I.A., Investigation of stability of asymmetrically supported rotors, 2:56269
Kovalev, V.A., *See* Paton, B.E., 2:57097
Kowalski, G., Mineral industry in the Canadian economy: review and outlook, 2:56920
Koyama, T., *See* Shibato, E., 2:56466
Kozak, J.J., *See* Kress, J.W., 2:57216
Kozlov, F.A., Some problems of leaks in sodium-water steam generator, 2:56504 (CONF-760503—P1, pp 202-210)
See Subbotin, B.I., 2:56488
Kozlov, V.A., *See* Aleksandrov, Y.A., 2:57562
Kozubovskii, V.R., *See* Danileiko, M.V., 2:57290
Kozyrev, Y.P., *See* Bykovskii, YW.A., 2:57784
Kraft, G., *See* Mokler, P.H., 2:57542
Krainskii, I.L., *See* Bronshtein, I.M., 2:57498
Krakowski, R.A., First wall thermal—mechanical analyses of the reference theta-pinch reactor, 2:57719
Kran, A., *See* Schwuttke, G.H., 2:56031
Krase, J.M., *See* McDonald, C.F., 2:56447
Krasnoyarov, N.V., Radioactive product behavior during the operation of sodium-cooled reactors of the USSR, 2:56481 (CONF-760503—P1, pp 30-34)
Krasovskii, O.G., *See* Budzhenko, A.I., 2:57055
Krauskopf, K.B., *See* Frye, J.C., 2:55919
Krauss, M., *See* Stevens, W.J., 2:57502
Kravtsov, N.V., Kinematic mode locking in a solid-state laser, 2:57293
Kreider, K.G., Waste heat management guidebook. Final report, 2:57043 (PB—264959)
Kreinin, E.V., Method of processing coal channels in underground coal gasification, 2:55585
Kreisman, W.S., *See* Kirkpatrick, A.R., 2:56040
Kremser, J., Some aspects of sodium technology issued from the operating experience of RAPSODIE and PHENIX, 2:56478 (CONF-760503—P1, pp 1-11)
Krentsel, B.A., Contribution to the chemistry of oligo-olefins, 2:55773
Kreppel, H., *See* Clausmeyer, H., 2:56678
Kress, J.W., Estimate of the intermolecular polarization contribution to the static dielectric constant of water, 2:57216
Krickenberger, K., *See* Bliss, C., 2:56923
Kristal, R., *See* Bartsch, R.R., 2:57661
Kristoferson, L., Waterpower: a short overview, 2:56003
Krivitskaya, N.A., Some problems of hydraulic calculation of gas pipelines transporting gas and air mixture, 2:55824
Krizmanic, K., Description of the waterflooding computation methods for oil fields, 2:55762
Kroebig, H.L., Fusible heat sink for a cryogenic refrigerator, 2:57265 (AD-D—003515)
Kroeger, W., Assessment of underground siting of a nuclear power plant with PWR as an engineered safety feature, 2:56809
Kroepfl, H., *See* Lettau, H., 2:56467
Kruer, W.L., Wave-breaking amplitudes in warm, inhomogeneous plasmas, 2:57676 (UCRL—79604)
See Thomson, J.J., 2:57772

Krug, V.V., *See* Smirnov, V.I., 2:56696
Kruger, C.H., *See* Eustis, R.H., 2:56996
Kruger, P., Radon emanation in geothermal steam, 2:56196
Kruglova, I.M., *See* Nikolaev, V.S., 2:57539
Kruse, T.H., *See* Griffin, P.M., 2:57219
Krushel'nitskii, N.Z., *See* Dzhigit, G.A., 2:56338
Krutiev, V.A., Investigation of the effect of nitrogen-containing fuel additives on the formation of nitrogen oxides, 2:55805
Kryanin, N.R., *See* Zorev, N.N., 2:57121
Kryter, R.C., Noise diagnostics for safety assessment quarterly progress report, January—March 1977, 2:56368 (ORNL/NUREG/TM—112)
Ksinsik, D., *See* Berndt, M., 2:55809
Ku, T., *See* Richards, P., 2:57243
Kubota, S., Development on the refueling machine for prototype advanced thermal reactor 'Fugen', 2:56468
Kubseryb, V.I., *See* Dunskii, V.D., 2:56295
Kuchinskii, V.V., *See* Zhiglinskii, A.G., 2:57640
Kuchumova, E.O., Analysis of characteristics of impulse discharge of high-capacity steam turbines, 2:56280
Kuehn, G., *See* Gomm, H., 2:55803
Kuehn, R., Petrochemical basic products from coal, 2:55627
Kuemmerle, E.W., *See* Larsen, J.W., 2:55631
Kugeler, K., *See* Niessen, H.F., 2:56613
Kugeler, M., *See* Niessen, H.F., 2:56613
Kuhn, L, *See* Fickert, W., 2:57334
Kuhn, W.L., Computational technique for estimating corrosion product release in an LMFBR, 2:56513 (CONF-760503—P1, pp 280-283)
Kulcinski, G.L., *See* Bullough, R., 2:57143
See Weber, W.J., 2:57150
Kulichikhin, V.V., Investigation of the operation of a T-100-130-type turbine made by the UTMZ plant in steamless regime, 2:56287
Kulikova, L.V., *See* Lanskaya, K.A., 2:57123
Kulwich, M.R., Breeding performance optimization of helium-bonded carbide fuel in 1500-MW(e) LMFBRs, 2:56549
Kuncz, F.F., Electron beam welding using fusion and cold wire fill, 2:57090 (GEPP—297)
Kunhardt, E.E., An experimental and theoretical study of the propagation of high amplitude pulses in a bounded magneto-plasma. Interim report, 2:57674 (AD-A—037663)
Propagation of nonlinear waves along a magneto-plasma column, 2:57678
Kunitake, H., Improvement of fracture toughness in reactor pressure vessel steel plates, 2:56385
Kuntysh, V.B., *See* Piir, A.E., 2:56234
Kunz, A.B., *See* Jennison, D.R., 2:57158
Kuperman, A.Ya., *See* Koltunov, V.S., 2:55996
Kuperman, D.I., *See* Shastin, E.G., 2:56275
Kuppermann, A., Progress in the quantum dynamics of reactive molecular collisions, 2:57531
Kuprikov, V.I., *See* Gonchar, V.Y., 2:57613
Kurilovich, N.F., *See* Sirota, A.N.N., 2:57188
Kuriyama, R., *See* Kihara, H., 2:56680
Kurnosov, A.T., *See* Vinogradnik, M.V., 2:56277
Kurokawa, R., *See* Akino, F., 2:56649
Kurpriyanov, S.E., *See* Volchenok, V.I., 2:57295
Kurstedt, H.A. Jr., Optimal set of selected enrichments that minimizes blending consequences, 2:55894
See DePorter, E.L., 2:55873
Kury, J.W., Explosive testing at the Lawrence Livermore Laboratory: philosophy and practice, 2:57349 (UCRL—79391)
Kuryshko, G.I., *See* Shnitser, I.N., 2:57327
Kusayama, Y., *See* Matsumura, J., 2:56705
Kuschel, D., Nuclear reactor with a containment and reactor pressure vessel and a pressure suppression vessel arranged in the containment, 2:56393
Kussmaul, K., Assessment of toughness and cracking in the heat-affected zone of light water reactor components, 2:56386
Kutasov, R.F., Heat treatment of large-sized welded steam turbine rotors for nuclear power plants, 2:56268
Kutikov, A.R., *See* Balezin, S.A., 2:56256
Kutta, H.W., *See* Burk, E.H. Jr., 2:55633
Kuz'micheva, L.V., *See* Zubov, I.V., 2:56297
Kuz'minov, B.D., Manifestations of the viscosity of a fissioning nucleus in the kinetic energy of the fragments, 2:57610
Kuzhevskii, B.M., Radioactive nuclei and the gamma-ray background of the quiet Sun, 2:57484
Kuzmicheva, L.V., *See* Zubov, I.V., 2:56291
Kuzminskii, S.S., *See* Busyrev, A.I., 2:56005
Kuznetsov, E.K., *See* Subbotin, B.I., 2:56488
Kuznetsov, E.V., *See* Ryabchenkov, A.V., 2:57137
Kuznetsov, V.G., Paleozoic carbonate formations in the south-east of Russian Platform and their oil and gas potential, 2:55752
See Shirokov, A.P., 2:55694
Kuznetsov, V.M., Polarization characteristics of coherent bremsstrahlung with off-axis collimation, 2:57572
Kuznetsova, L.V., *See* Dal'yan, I.B., 2:55751
Kwak, H., *See* Horton, W. Jr., 2:57665
Kwan, L.I., *See* Marhic, M.E., 2:57639
Kwiatkowski, J.W., *See* Jewell, W.S., 2:55902
Kydes, A.S., *See* Carroll, T.O., 2:56915

L

La Villa, F., Mercury titration in natural gas by flameless atomic absorption, 2:55827
Laats, E.T., *See* Dearien, J.A., 2:56369
Lackey, W.J., Improved gas distributor for coating HTGR fuel particles, 2:55872
Lacroix, A., *See* Kremser, J., 2:56478
Lago, R.M., Manufacture of hydrocarbons, 2:55982
Manufacture of hydrocarbons, 2:55986
Lagun, V.P., *See* Shapiro, G.A., 2:56304
Lahiri, A., *See* Biswas, S.C., 2:55549
Lai, D., FORMS: a generator of time-card forms, 2:57817 (UCID—30151)
MANAGER: a generator of reports on the expenditure of scientific manpower, 2:57818 (UCID—30152)
Laist, D.W., *See* Noble, J.B., 2:56582
Lakner, J.F., High pressure apparatus for hydrogen isotopes to pressures of 345 MPa (50,000 psi) and temperatures of 1200°C, 2:57253 (UCRL—78886)
Lakomy, D.G., *See* Mrochek, J.E., 2:57201
Lalevic, B., *See* Anderson, W.A., 2:56075
Lam, S.T., Titanium—oxygen system: review of structure, thermodynamics, and phase equilibria, 2:57154 (UCRL—13726)
Lambropoulos, P., Multiphoton processes with polarized light, 2:57545
Lamich, G., *See* Gruen, D.M., 2:57002
Lance, R.H., Mechanical behavior of materials and structural elements at elevated temperatures. Progress report, June 1, 1976—May 31, 1977, 2:57110 (COO—2733-11)
Landa, G.R., Improving the efficiency of low-capacity gas turbine engines, 2:56324
Landa, P.S., Natural fluctuations of the tunnel current in Josephson junctions, 2:57266
Landrum, J.H., *See* Hulet, E.K., 2:57601
Landt, J.A., *See* Bobbett, R.E., 2:57340
Landwehr, H., *See* Angelini, A., 2:56732
Lanfermann, W., Spill-plate apparatus for a mining machine, 2:55675
Langdon, A.B., *See* Thomson, J.J., 2:57772
Lange, K.H., Gas turbine power plants of large unit capacity in standard construction, 2:56228
Langer, S.H., Impulsive solar x-ray bursts. 3. Polarization and directivity of bremsstrahlung radiation from a beam of electrons directed toward the photosphere, 2:57482 (N—77-16976)
Impulsive solar x-ray bursts. 4: polarization, directivity and spectrum of the reflected and total bremsstrahlung radiation from a beam of electrons directed toward the photosphere, 2:57483 (N—77—16977)
Langerman, M.A., Semiscale Mod-1 system response during the ECC baseline test series (design of the Mod-1 baseline ECC test), 2:56408 (TREE-NUREG—1058)
Langhaar, J.W., Design of containers for shipping unirradiated LMFBR assemblies, 2:57275 (DP-MS—77-5)
Lanskaya, K.A., Working capacity and reliability of pipes made of steel 12Cr1MoV after long periods of operations, 2:57123
Lanzavechia, L., *See* Cogliati, A., 2:57027
Laporte, J.L., *See* Espitalie, J., 2:55746
Lapshin, R.M., *See* Shemagin, I.A., 2:57300
Laptev, A.V., *See* Belokurova, I.N., 2:57152
Larabi, M., Articulated loading platform (ALP), 2:55800
Larsen, J.W., Chemistry of coal surfaces, 2:55631 (CONF-760885—, pp 1-13)
Larue, J.C., Gas stream thermal cycling apparatus, 2:56058
Lathrop, K.A., *See* Tsui, B.M.W., 2:57439
Latzko, D.G.H., *See* Spaas, H.A.C.M., 2:56384
Laurent, P., *See* Reynen, J., 2:56383
Lauver, R., *See* McDonald, G., 2:56137
Laval, G., *See* Waddell, B.V., 2:57662
Lavelle, G., Double-helical regions in Kilham rat virus DNA, 2:57409 (CONF-770555—1)
See Li, A.T., 2:57410
LaVeque, E.G., *See* DiCanio, D.G., 2:55732, 2:55733, 2:55734
Law, M.E., *See* Auer, I.P., 2:57567
Law, P.K., *See* Berkner, K.H., 2:57798
Lawrence, R.J., High pressure multiple shock response of aluminum, 2:57117 (SAND—77-0027C)
Lawver, B.S., Operators guide: Atmospheric Release Advisory Capability (ARAC) site facility, 2:57368 (UCID—17490)
Lazareth, O., Conduction-cooled minimum activity blankets for TNS and EPR fusion reactors, 2:57746
See Fillo, J.A., 2:57727, 2:57729
See Powell, J., 2:57793
Lazarev, I.P., *See* Shterenshis, I.P., 2:56687
Laznow, J., *See* Hamawi, J.N., 2:57372
Le, H.V., Floatability of coal and pyrite, 2:55553 (IS-T—779)
Le Frere, J.P., Electromagnetic induction pump, 2:56579
Le Goff, Y., Shale tomorrow. I. The world situation, 2:55829

Leavell, W.H., Tracking nonstationary velocity in two-phase flow by an adaptive cross-correlation algorithm, 2:56814
Lecarpentier, P., *See* Baylac, G., 2:56419
Lecocq, A., *See* Faugeras, P., 2:56459
Ledent, P., Underground coal gasification, 2:55588
Lee, D., Microstructure, deformation, and fracture behavior of reactor core materials, 2:56653
See Hulet, E.K., 2:57601
Lee, E.L., Equations of state for detonation products of high energy PBX explosives, 2:57348 (UCID—17540)
See Kury, J.W., 2:57349
Lee, J.D., *See* Bender, D.J., 2:57713
Lee, P.K., *See* Keeton, A.R., 2:56510
Lefebvre, C., Positive safety system with control relay and current regulation functions, 2:56738
Positive safety control system, 2:56739
Lefevre, R.L.R., Method and fluidized bed furnace for coating nuclear fuel particles and others, 2:56714
LeFrois, R.T., Inorganic phase change materials for energy storage in solar thermal program, 2:56158
LeGore, R.S., Effects of geothermal energy utilization on stream biota and water quality at The Geysers, California. Final report, 2:56195 (NP—21722)
Lehmberg, R.H., Optical pulse squaring effects in a dispersive delay line, 2:57768 (NRL-MR—3525)
Lehner, J., *See* Hsieh, S.Y., 2:57735
See Powell, J.R., 2:57715
Leibowitz, L., *See* Green, D.W., 2:55867
Leitz, C., Treatment of the influence of irradiation in design and operation control of pressure vessels of pressurized- and boiling-water reactors, 2:56380
Leonard, J.A., Sandia's solar total energy program, 2:56099 (SAND—75-5880)
Leonkov, A.M., *See* Ivanov, V.A., 2:56299
Leplat, P., *See* Espitalie, J., 2:55746
Lepp, R.M., Controllability studies for an advanced CANDU boiling light water reactor, 2:56731
Leribaux, H.R., *See* Blander, M., 2:57128
Leshchenko, V.E., *See* Borisov, A.V., 2:55807
Lesnichenko, A.Ya., *See* Kulichikhin, V.V., 2:56287
Lesnikov, A.P., *See* Gulin, E.I., 2:57062
Lessard, D.R., *See* Agmon, T., 2:56917
Lettau, H., Fuel element for heavy water moderated nuclear reactors, 2:56467
Levchenko, G.I., *See* Lokshin, V.A., 2:56315
Levin, A.M., *See* Iverovskii, E.N., 2:55692
Levin, G.Kh., *See* Viksman, A.S., 2:57058
Levin, M.I., Principles of setting up automated rigs to test diesel engines in conditions close to the operational ones, 2:57019
Levina, S.R., *See* Dorfman, L.A., 2:56327
Levkin, G.M., Investigation of the effect of the design and number of piston rings on lubricant burn-up waste, 2:57057
Levy, E.K., *See* Clump, C.W., 2:55712
Lewis, A.E., Modified in-situ oil shale technology at the Lawrence Livermore Laboratory: experimental results and present status, 2:55837 (UCRL—79149)
Lewis, H.D., Fundamental statistical methods in particle science, 2:57181 (LA-UR—77-1098)
Lewis, H.E., Solvent refined coal (SRC) process operation of solvent refined coal pilot plant at Wilsonville, Alabama. Monthly technical progress report for June 1977, 2:55625 (FE—2270-17)
Lewis, R., Coal pressurization and feeding use of a lock hopper system, 2:55563 (CONF-770655—1)
Li, A.T., DNA replication of the parvovirus Kilham rat virus. I. Characterization of intracellular forms of viral DNA extracted by guanidine hydrochloride, 2:57410 (CONF-770555—2)
Libbin, J.D., *See* Boehlje, M., 2:55731
Libby, H.F., Coal catalyst, 2:55629 (AD-D—003508)
Libenson, B.N., *See* Bronshtein, I.M., 2:57498
Lichtenstein, H., *See* Steinberg, H.A., 2:56806
Lieber, A.J., Subpicosecond proximity-focused streak camera for x-ray and visible light, 2:57643
Lievens, F., Sodium characterization during the starting period of a sodium loop, 2:56490 (CONF-760503—P1, pp 105-111)
Liewer, P.C., *See* Allen, A.W., 2:57671
Lilien, D., *See* Lim, C.B., 2:57422
Lim, C.B., Fast iterative method for 3-D positron image reconstruction, 2:57425
Performance characteristics of the large field scintillation gamma cameras, 2:57422
Lin, B.I., Optimal in-core fuel management for boiling water reactors, 2:56371
Lindahl, P.A. Jr., New designs in currently marketed cooling towers, 2:56238
Lindauer, R.B., *See* Pechin, W.H., 2:55936
Lindemer, T.B., Kernel migration for HTGR fuels from the system Th-U-Pu-C-O-N, 2:56446
See Pearson, R.L., 2:56428
Linder, P., Risk comparison of alternatives of the back end of the fuel cycle at a pre-project stage, 2:55946
Lindholm, F.A., Basic mechanisms governing solar-cell efficiency, 2:56071
Lindow, J.T., *See* Breiner, S., 2:55859
Lindsay, W.W., Regulatory issues in nuclear fuel accounting and rate making, 2:56589
Lineberger, W.C., Photodetachment threshold processes, 2:57544
Lingenfelter, R.E., *See* Ramaty, R., 2:57485
Linnerooth, J., *See* Otway, H.J., 2:55941
Lipska, A.E., Proposed safety standards for ERDA trailers and other portable structures, 2:57313 (UCID—17456)
Liselkin, I.D., *See* Lokshin, V.A., 2:56315
Lister, D.M., Installation of DSS/2 on the IBM 360/195 computer at K-25, 2:57810 (K/CSD/TM—14)
Listovets, V.S., *See* Bavel'skii, D.M., 2:56314
Litovchenko, A.P., *See* Terekhova, A.I., 2:57041
Litovkin, V.V., *See* Shnitser, I.N., 2:57327
Little, M.W., Flame suppression on cylindrical fuel rods, 2:57248
Liu, C.S., *See* Grebogi, C., 2:57686
See Tripathi, V.K., 2:57668
Liu, M., The chemistry, dispersion, and transport of air pollutants emitted from fossil fuel power plants in California: data analysis and emission impact model. Final report, 2:57357 (PB—264822)
Liubimova, E. A., Development of geothermal models, 2:56178
Livengood, C.D., *See* Huber, C.C., 2:56746
Livey, D.T., Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R—1746)
Livshits, M.A., Dynamic characteristics of a boiler with combined circulation of a medium, 2:56294
Lo, R.K., *See* Eberhart, J.G., 2:56766
See Penn, W.J., 2:56460
Lobov, G.A., Production of ultrafast pions in collisions of relativistic deuterons with protons and nuclei, 2:57584
Loda, G., Investigation of coupling of field emission cold cathode guns for gas lasers. Final technical report, 2:57283 (AD-A—037734)
Logan, C.M., *See* Behrisch, R., 2:57494
Logan, K.W., *See* Schlapper, G.A., 2:57423
Loh, W.P., Simultaneous load analysis of an electricity and district-heating supply system, 2:56227
Lokshin, V.A., Industrial tests of a membrane economizer on a TP-120 boiler at the Saratov No.2 heat-and-power plant, 2:56315
London, R.E., Use of ^{13}C and ^{1}H nuclear magnetic resonance to probe internal motion in dimethyl sulfoxide, 2:57232
Long, A., *See* Stevens, A.L., 2:55831
Long, G.M., Add-on sectionalizing valves for medium-pressure systems, 2:55817 (CONF-770577—1)
Longanbach, J.R., *See* Che, S.C., 2:55618
Lookabill, H.J., *See* Davis, J.W., 2:57314
Lopez, J., *See* Cronauer, D.C., 2:55609
Lorber, J., *See* Kurstedt, H.A. Jr., 2:55894
Lorenz, H., *See* Dietz, W., 2:56517
Lorenz, S., *See* Burton, L.C., 2:56028
Lorenzen, H., *See* Lux, K.H., 2:55828
Lorenzi, A., Two-phase flow-rate measurement with sharp-edged orifices. theoretical investigation, 2:57298
Lorsch, H.G., *See* Kauffman, K.W., 2:56165
Lougheed, R.W., *See* Hulet, E.K., 2:57601
Loughran, E.D., Influence of metals on the thermal decomposition of s-triaminotrinitrobenzene (TATB), 2:57345 (LA—6873-MS)
Love, W.J., Fracture in straight pipes under large deflection conditions. II. Pipe pressures, 2:56374
See Emery, A.F., 2:56661
See Kobayashi, A.S., 2:56658, 2:56672
Loveland, W., Large collision residues and nuclear fission in the interaction of 25.2-GeV ^{12}C with uranium, 2:57604
Lovell, E.G., *See* Abdel-Khalik, S.I., 2:57782
Loventhal, A., *See* Berg, M.E., 2:57240
Lozhkin, O.V., *See* Avdeichikov, V.V., 2:57593
Lubatti, H.J., *See* Baker, M., 2:57583
Lubenau, J.O., *See* Nussbaumer, D.A., 2:57430
Luce, J.S., *See* Gullickson, R.L., 2:57653
Luce, R.G., CDIF combustor Instrumented Test Section. Final report, 2:56988 (TID—27147)
Ludewig, H., *See* Steinberg, M., 2:55906
Ludke, P.R., *See* Jones, M.C., 2:56360
Lue, J.W., Superconducting toroidal field magnets for a tokamak engineering test reactor, 2:57739
See Sviatoslavsky, I.N., 2:57718
Luetkenhaus, H.J., Geamatic 2000 I, a new automation system for underground mining installations, 2:55705
Luguev, S.M., High-temperature thermal conductivity of La_3Te_4, 2:57180
Luhman, T., Influence of tensile stresses on the superconducting temperature of multifilamentary Nb_3Sn composite conductors, 2:57107 (BNL—23016)
Luhmann, N.C. Jr, Experimental simulation of parametric instabilities in laser-plasma interactions. Interim report, 2:57766 (AD-A—037761)
Lukashevich, V.E., *See* Blagoveshchenkii, V.V., 2:56336
Lundqvist, C.G., Remote terminal units, 2:56354
Luther, G., District heating pricing as an inducement for energy saving, 2:56912
Luthy, D.F., Volume reduction system for solid and liquid TRU waste from the

nuclear fuel cycle: January—March 1977, 2:55901 (MLM—2436)
Lutz, H.O., Impact parameter dependence of inner shell excitation, 2:57540
Lux, K.H., Requirements for salt cavity stability analysis, 2:55828
Luza, K.V., Seismicity and tectonic relationships of the Nemaha Uplift in Oklahoma, Kansas, and Nebraska, 2:57473
Lykhvar, N.V., *See* Palagin, A.A., 2:56339
Lyman, J.L., Model for unimolecular reaction of sulfur hexafluoride, 2:57213
Lyons, P., *See* Franks, L.A., 2:57309
Lyons, W.A., Mesoscale air pollution transport in southeast Wisconsin. Final report 1972-1976, 2:57361 (PB—265382)
Lyubimov, V.B., *See* Angelov, N., 2:57570, 2:57571
Lyudomirskii, B.N., *See* Kulichikhin, V.V., 2:56287
Lyutov, S.I., *See* Angelov, N., 2:57570, 2:57571
Lyuttsov, K., *See* Akkerman, G., 2:56394

M

Maa, P.S, *See* Aczel, T., 2:55635
Macbeth, P.J., Measurements of surface radon fluxes from uranium mill tailings, 2:55940
MacDonald, J.M., Process for the preparation of low pour point lubricating oils, 2:55771
Macdonald, J.R., Experimental studies of target and projectile X radiation in high velocity atomic collisions, 2:57538
MacDonald, P.E., Effect of pellet cracking on light water reactor fuel temperatures, 2:56392
Maciel, G.E., *See* Bartuska, V.J., 2:55639
Mack, K.J., *See* Wild, E., 2:56493
Mackenzie, W.D.C., Business systems for hydrocarbon resources: their credibility in retrospect and in prospect, 2:55816
MacKinnon, J.G., *See* Williamson, T.G., 2:57339
MacPherson, H.G., *See* Whittle, C.E., 2:56741
Macrae, W., *See* Evans, A.D., 2:56541
Macriss, R.A., Control of the level of NO/sub x/ in the indoor environment, 2:57459 (CONF-770557—2)
Madden, R.P, Atomic physics with synchrotron radiation, 2:57558
Madec, M., *See* Espitalie, J., 2:55746
Madoyan, A.A., *See* Rybalko, V.K., 2:57320
Maeshima, M., *See* Bankoff, S.G., 2:56532
Magnuson, C.F., Shock and vibration environments for large shipping containers on rail cars and trucks, 2:57278 (SAND—76-0427)
Mahlum, D.D., Biological implications of magnetic fields from fusion reactors, 2:57759
Maienschein, F.C., Where are we and where are we going in reactor shielding, 2:56651 (CONF-770401—5)
Malkov, V.N., *See* Aleksandrov, Y.A., 2:57562
Major, D.J., Oil conservation and reclamation, 2:55789
Majestic, J.R., *See* Buchan, R.M., 2:56097
Majorowicz, J., Heat flow map of Poland on the background of the European geothermal field and some aspects of its interpretation, 2:56187
Majumdar, D., Boiling pool analysis during transition to the transition phase of core disruptive accidents in LMFBRs, 2:56844
See Fillo, J.A., 2:57730
Makarov, V.I., Manifestations of 2 1/2-order transitions and Kohn singularities in the pressure dependence of the superconducting transition temperature, 2:57625
Makarov, V.M., *See* Kozlov, F.A., 2:56504
Makarov, V.N., *See* Tyryshkin, V.G., 2:56313
Makeicheva, I.I., *See* Denisov, G.N., 2:55997
Maki, H., *See* Hosokawa, T., 2:56717
Maki, K., Fuel rod in a reactor, 2:56720
Maki, L.M., *See* Asquith, J.G., 2:56760
Makowitz, H., *See* Fillo, J.A., 2:57730
Maksimov, A.I., *See* Ryabchenkov, A.V., 2:57137
Maksimov, S.P., Cyclic character of the processes of oil and gas generation, petroliferous provinces, basins and regions, 2:55742
Maksudov, T.M., *See* Vakhidov, A.T., 2:56135
Makuchowski, E.J., *See* Stein, N.A., 2:57566
Mal'chenko, T.V., *See* Andreev, V.A., 2:57042
Malang, S., Method to calculate the influence of gas bubbles in liquid-metal cooled reactors, 2:56561
Malet, J.C., *See* Fruchard, Y., 2:56580
Malinauskas, A.P., *See* Dyer, F.F., 2:56436
See Wichner, R.P., 2:56435
Malmqvist, L.G., *See* Lundqvist, C.G., 2:56354
Malov, V.V., Improving the reliability of automatic calculation of technical and economic performance indices by the automatic error correction method, 2:56292
Maly, J., *See* Siri, W.E., 2:55957, 2:55958
Malyarov, V.V., Singlet even nucleon-nucleon potentials obtained by an algebraic method for the inverse problem of scattering theory, 2:57590
Malyushenko, V.V., *See* Aleksapol'skii, D.Ya., 2:56684
Mamaev, S.G., Energy and pressure of fermion pairs created near the Friedmann singularity, 2:57488
Mambretti, C., *See* Fumero, R., 2:55972
Mamedov, G.Kh., Complex utilization of raw materials and materials by chemical industry in conditions of automated norm-setting system of the azerbaijan republic, 2:57033
Mandas, N., *See* Bernardini, C., 2:56121
Mandeville, D., *See* Michard, G., 2:56193
Manickam, J., *See* Chance, M.S., 2:57663
Maniscalco, J.A., Comparative study of exploratory reactor concepts for inertial confinement fusion, 2:57779
Laser fusion technology and experiments, 2:57775
Liquid—lithium waterfall inertial confinement fusion reactor concept, 2:57747
Mann, L.K., *See* Shriner, D.S., 2:57351
Mansur, L.K., *See* Brailsford, A.D., 2:57145
Manthos, G.J., Economic comparison of two BIGAS coal gasification processes, 2:55570 (FE—2024-4)
Mapes, J.R., *See* Nussbaumer, D.A., 2:57430
Mar, H.Y.B., Low cost coatings for flat plate solar collectors, 2:56126
Marchese, A.R., *See* O'Reilly, P., 2:56833
Marchevskii, V.P., *See* Dzhigit, G.A., 2:56338
Marchok, A.C., *See* Steele, V.E., 2:57453
Marcus, P.A., DEROCS: a computer program to simulate offshore oil and natural gas development scenarios and onshore service base requirements, 2:55757 (USGS-OFR—77-130)
Marens, M., Combined system for power and desalinated water production by nuclear power stations, 2:56610
Margolina, R.V., *See* Postolovskii, S.N., 2:57039
Margulis, M.A., Energetics and mechanism of sonochemical reactions. V. The formation of hydrogen peroxide in the sonolysis of water and aqueous solutions of formates, 2:55998
Margulova, T.Kh., Usefulness and methods of periodic treatment of extrareactor part of single-loop nuclear power plants, 2:56682
See Zubov, I.V., 2:56297
Markic, M.E., Axial density and temperature variations in a magnetically confined arc, 2:57639
Marinelli, V., Critical heat flux: a review of recent publications, 2:56639
Marinescu, M., Influence of additives obtained from alkaline metals on soot concentration of hydrocarbon diffusive-laminar flames, 2:55980
Maringer, R.E., *See* Gelles, S.H., 2:57092
Markina, A.P., *See* Zalkind, V.I., 2:56995
Markley, R.A., *See* Carelli, M.D., 2:56530
Markovskii, I.A., *See* Berlyand, V.I., 2:56340
Markowski, F.J., *See* McCall, T.B., 2:56829
Markushin, V.E., *See* Lobov, G.A., 2:57584
Maroni, V.A., Some perspective on tritium permeation in fusion reactors based on existing data and experience, 2:57760
See Yonco, R.M., 2:57131
Marquet, A., Few aspects of the behavior of a cryogenerator in a big electric system, 2:57269
Marquis, F., *See* Espitalie, J., 2:55746
Marr, W.W., *See* Hwang, I.T., 2:56856
Marrero, T.R., Airborne iodine-131 released from boiling water reactor plant, 2:56377
Marshak, Yu.L., *See* Goncharov, A.I., 2:55729
Marshall, B.W., *See* Schueler, D.G., 2:56078
Marshall, J.E., Incineration of domestic refuse: power from refuse at Kynoch works, 2:56249
Marshall, S.J., *See* Munis, R.H., 2:57003
Martell, C.J., *See* Hansel, J.M., 2:57197, 2:57198
Martin, C., High-current plasma accelerator for the investigation of plasma wall interaction, 2:57654
Martin, H.W., Water pollution caused by inactive ore and mineral mines - a national assessment. Final report, 2:57393 (PB—264 936)
Martin, J.M., Role of antiwear additives for lube oils in a friction test simulating ring-liner contact, 2:55775
Martin, M., *See* Berdahl, P., 2:56138
Martinez, J., Solar cells from polysilicon rods, 2:56056
Martynov, Yu.D., *See* Trukhnii, A.D., 2:56302
Martz, C.W., Solar energy source book, 2:56103
Mashiko, Y., *See* Kanroji, Y., 2:56191
Maslenok, B.A., *See* Balandin, Yu.F., 2:56694
Mason, D.D., Segregation induced embrittlement of grain interfaces, 2:57111 (COO—3084-52)
Mason, R.H., West Virginia Univ. professors work for electrical safety, 2:55677
Massey, H., Negative ions, positive electrons, 2:57555
Masterson, C., Facilitating the use of solar building technologies; a report on work in progress, 2:56026
Masuko, N., Adsorption of metal ions on colloidal silica, 2:56210

Mathe, P., *See* Anderson, W.A., 2:56075
Matheson, M.S., *See* Jonah, C.D., 2:57239
Mathiesen, M., *See* Brolin, T., 2:57046
Matinyan, S.G., Radiative corrections to the classical Lagrangian and dynamical symmetry breaking, 2:57587
See Esaibegyan, S.V., 2:57577
Matoney, J.P., *See* Saperstein, L.W., 2:55684
Matorina, B.E., *See* Mitor, V.V., 2:56316
Matskevich, G.V., *See* Pis'man, B.Ya., 2:56681
Matsumoto, K., *See* Hasegawa, M., 2:56540
See Nishimaki, K., 2:56691
Matsumura, J., Water supply system, 2:56405
Water supply system, 2:56705
Matsumura, M., Thermal distortion of mock-up reactor vessel of fast breeder reactor, 2:56556
Matsuo, K., *See* Sakai, T., 2:57083
Mattes, K., *See* Huber, F., 2:56499
Matthews, H.B., Geothermal energy control system and method, 2:56203
Matthews, W.T., Method of removing dissolved non-condensibles from geothermal brines, 2:56199
Matthieussent, G., *See* Gervais, F., 2:57677
Matulenko, Y.A., *See* Akopin, V.D., 2:57569
Matusevich, V.M., Mercury in underground waters of the West Siberian oil and gas bearing basin, 2:57477
Matveev, V.V., Investigation of the effect of the technical condition indices of internal combustion engines on working process parameters by numerical modeling method, 2:57063
Matwiyoff, N.A., *See* London, R.E., 2:57232
Matzie, R.A., Alternative fuel cycle for Nuclear Energy Centers, 2:56601
Maulbetsch, J.S., EPRI Research Program in cooling tower technology and environmental impacts, 2:56239
Maung, H.M., Investigation into strata behaviour around an experimental longwall caving face in Jharia coalfield, 2:55699
Maurer, R.J., Research in materials science. Final technical report, 2:57100 (AD-A—037760)
Mausbeck, H., Materials experience with large sodium loops and components, 2:56486 (CONF-760503—P1, pp 67-74)
Mavraganis, P., *See* Gerard, A., 2:57360
Max, C.E., *See* Thomson, J.J., 2:57772
Maynard, C.W., *See* Gohar, Y., 2:57726
Mayo, C.W., Experience in diagnostic and surveillance methods development, 2:56363
Mayo, F.R., Oxidations of coal, coal fractions, and coal models, 2:55637 (CONF-760885—, pp 189-201)
Mayr, G., *See* Schlaich, J., 2:56449
Mayrhofer, M., *See* Herberg, G., 2:56559
Mazzia, M., *See* Cogliati, A., 2:57027
McAlees, D.G., *See* Uckan, N.A., 2:57714
McBride, J.R., Coal liquefaction: technology, impacts, and technical suitability for Montana, 2:55614 (NP—22092)
McCall, T.B., Loss of one heat transport loop without reactor trip, 2:56829
McCandless, F.P., *See* Berg, L., 2:55556
McCarthy, I.E., (e,2e) reaction, 2:57550
McChesney, M., Modern materials for underground support, 2:55689
McClure, D.J., Dynamics of the reaction $D^+_3 + O(^3P)$ $OD^+ + D$, and the influence of the atomic quadrupole moment on the cross section at very low kinetic energies, 2:57514
McConald, G., Sharing the Sun: solar technology in the seventies. Volume 6, 2:56136
McCormick, B.H., *See* Thie, J.A., 2:56595
McCormick, J.R., *See* Hopkins, R.H., 2:56032
See Hunt, L.P., 2:56041
McCormick, N.J., Unique field-readable Type E security seal, 2:55967
McCown, J.J., Sodium and cover gas chemistry in the high temperature sodium facility, 2:56489 (CONF-760503—P1, pp 94-104)
Mcdermott, P., Secondary aerospace batteries and battery materials: a bibliography, 1969 — 1974, 2:56888 (N—77—16437)
McDonald, C.F., Ammonia turbomachinery design considerations for the direct cycle nuclear gas turbine waste heat power plant, 2:56440
Nuclear gas turbine power plant activities in the United States, 2:56447
McDonald, G., Development of low-cost procedures for application of solar selective black chrome, 2:56137
McDonald, R.C., *See* Wolverton, B., 2:55994
McDowell, M.R.C., Electron impact excitation of light atoms, 2:57522
McElroy, M.W., Guidelines for industrial boiler performance improvement. (Boiler adjustment procedures to minimize air pollution and to achieve efficient use of fuel), 2:57035 (PB—264543)
McFadzean, T.B., Rock-fluid relationship studies on the Windfall D-3A reservoir and their application in evaluatiang gas cycling effectiveness, 2:55744
McGrath, S.V., Equating degrees of freedom in the SAP finite element code, 2:57809 (K/CSD/TM—13)
McGruer, J.N., *See* Choyke, W.J., 2:57148
McGuire, R.R., *See* Kury, J.W., 2:57349
McIntosh, J.A., Canadian reserves of seven metals, 2:56933
McKenna, K.F., End loss from a collision dominated theta pinch plasma, 2:57630
McKone, T.E., Tritium health effects during normal and off-normal release in CTRs, 2:57763
McKoy, V., *See* Bender, C.F., 2:57554
McMullan, R.K., *See* Koetzle, T.F., 2:57209
McMullen, T.B., *See* Faoro, R.B., 2:57354
McMullin, J.N., Evolution and thermonuclear yield of a high β plasma column, 2:57631
McMurtry, G.M., Chemical and isotopic investigations of groundwater in potential geothermal areas in Hawaii, 2:56189
McNamara, B., Magnetic fusion energy, 2:57691 (UCRL—79600)
McNeil, J.R., *See* de Hoog, F.J., 2:57287
McNeil, M.B., *See* Kreider, K.G., 2:57043
McNiven, H.D., Experimental assessment of the Mindlin—McNiven rod theory, 2:57120
McPhee, A.H., *See* Soeoet, O., 2:56655
McVey, J.R., Portable instrument measures four ventilation parameters, 2:55861
McWilliams, T.M., Using LSI processor bit-slices to build a PDP-11: a case study in microcomputer design, 2:57828 (UCRL—79581)
Mead, W.C., *See* Thomson, J.J., 2:57772
Meade, D.M., Divertors for impurity control in tokamaks, 2:57722
Meakin, J.D., CdS/Cu_2S solar cells: a low-cost thin film polycrystalline photovoltaic device for terrestrial applications, 2:56070
See Burton, L.C., 2:56028
Meckler, G., Design of energy-integrated building subsystems and their evaluation, 2:57012
Medonos, S., *See* Aamodt, B., 2:56668
Medovar, B.I., *See* Paton, B.E., 2:57097
Medvedev, V.A., *See* Lokshin, V.A., 2:56315
Meek, C.C., *See* Pekarsky, M.I., 2:56815
Meem, J.L., Three year's experience with a graduate nuclear engineering co-op program, 2:56629
Mega, T., Apparatus for controlling vapor temperature in a nuclear power plant, 2:56697
Mehlhorn, W., Resonances seen in secondary electron spectra, 2:57559
Mehner, A.S., *See* Quapp, W.J., 2:56808
Meier, H.U., Investigation of acid-resistant electrocatalysts for fuel cells, 2:56999 (N—77—16444)
Meier, W.R., *See* Maniscalco, J.A., 2:57747, 2:57779
Meisenheimer, R., *See* Behrisch, R., 2:57494
Meissner, C.R. Jr., Coal geology and the future. Symposium abstracts and selected references, 2:55547 (USGS-CIRC—757)
Mekhanikov, A.I., *See* Ol'khovskii, G.G., 2:56333
Mel'nikov, N.V., *See* Kontorovich, A.E., 2:55741
Mel'nikova, N.N., *See* Angelov, N., 2:57570, 2:57571
Melent'ev, L.A., Principles of nuclear district heating, 2:56611
Melfi, S.H., Tracking pollutants from a distance, 2:57366
Melnikov, N.A., Experimental investigation of He:Ne lasers stabilized by saturation absorption in iodine, 2:57289
Melsheimer, S.S., *See* Edie, D.D., 2:56168
Melvin, P., Oil spill and oil pollution reports, May 1976—July 1976. Quarterly report, 2:55792 (PB—264870)
Men'shikov, B.S., *See* Shastin, E.G., 2:56275
Mendelsohn, M., *See* Gruen, D.M., 2:57002
Meneley, D.A., *See* Trojan, O.A., 2:56627
Mengi, Y., *See* McNiven, H.D., 2:57120
Merezhko, V.P., *See* Shnitser, I.N., 2:57319
Meshchanin, A.P., *See* Akopin, V.D., 2:57569
Meskan, D.A., *See* Loda, G., 2:57283
Metcalfe, R., End face seals in high pressure water--learning from those failures, 2:56473
Meyer, J.F., *See* Carter, J.L., 2:56848
Meyer, R.O., Control material behavior in commercial reactors, 2:56722
Meyerhof, W.E., Quasimolecular K x-rays, 2:57505
Meyers, A.C. III, Academic program in solar energy science education, 2:56017
Miasnikov, A., *See* Rocek, J., 2:56469
Michaels, L., Investigation of hybrid systems for power systems analysis. The ac/hybrid power system simulator. Final report, 2:56356 (EEI-RP—90-2)
Michard, G., Subsuperficial changes in chemical composition of the thermomineral waters of Vichy basin. Geothermal implications, 2:56193
Mikhailov, L.I., *See* Kostin, A.K., 2:57328
Mikhailov, S.Ya., *See* Livshits, M.A., 2:56294
Mikhalev, V.G., *See* Babkin, G.V., 2:57658
Mikulina, Yu.D., *See* Antikain, P.A., 2:57132
Mikushkin, V.M., *See* Ogurtsov, G.N., 2:57516
Miles, A.J., Energy conservation in the production of hot water, 2:57016
Miles, C.C., *See* Villarreal, R., 2:56512
Miles, K.J., *See* Hwang, I.T., 2:56856
Miles, R., *See* Rahnema, F., 2:56802
Miley, G., *See* Choi, C., 2:57648

Miley, G.H., Approaches to small-size field-reversed mirror reactors, 2:57711
Laser-fusion concept using D-D-T pellets with the DNP laser feedback system, 2:57767 (COO—2007-82)
See Petrie, T.W., 2:57645
Miller, G., *See* Bartsch, R.R., 2:57661
Miller, J.R., *See* Jonah, C.D., 2:57239
Miller, J.W. Jr., *See* Hansen, K.C., 2:56034
Miller, L.G., *See* Brugger, R.M., 2:57802
Miller, R.L., *See* Hoffman, N.J., 2:56498
See Whitlow, G.A., 2:56494
Miller, S., Impact of thermal effluents on fish, 2:57443
Mills, J.C., *See* Salem, S.L., 2:56824
Mills, W.R. Jr., *See* Martin, H.W., 2:57393
Milner, A., *See* Wann, J.M.R., 2:55680
Milora, S.L., Geothermal energy as a source of electric power. Thermodynamic and economic design criteria, 2:56198
Milovanov, N.P., *See* Zhiglinskii, A.G., 2:57640
Mima, S., *See* Nakajo, Y., 2:57263
Min, T.K., *See* Chan, C.K., 2:56830
Minaev, E.V., *See* Styrikovich, M.A., 2:56348
Minato, A., *See* Naito, K., 2:56571
Minnibaev, R.Sh., *See* Andreev, V.A., 2:57042
Mirkin, I.L., *See* Trusov, L.P., 2:56255
Mironov, V.D., *See* Malov, V.V., 2:56292
See Pinkhasik, M.S., 2:56993
Miroshnikov, S.I., *See* Zel'vyanskii, A.S., 2:55707
Mishra, R.N., *See* Verma, B.S., 2:55701
Misolovin, A., *See* Greenspan, E., 2:56550
Mitchell, R.C., Gravel and liquid storage system for solar thermal power plants, 2:56156
Mitchell, T.J., *See* Morris, M.D., 2:57813
Mitchell, T.O., *See* Farcasiu, M., 2:55619
Mitchner, M., *See* Eustis, R.H., 2:56996
Mitor, V.V., Selection of the reasonable standard size and profile of power blocks for central Siberian conditions, 2:56316
Mitra, D., Dismantling and installation of longwall face with powered supports, 2:55698
Mitra, S., *See* Lavelle, G., 2:57409
Mitsutsuka, N., Fission product measurements in the inpile fission product loop, 2:56514 (CONF-760503—P1, pp 284-290)
Fission product deposition in a stainless steel sodium system, 2:56515 (CONF-760503—P1, pp 291-297)
Mittmann, U., Trolley-wire-operated underground locomotive with manual and remote control, including fully automatic control and speed regulation, 2:55706
Mitzel, F., *See* Caldarola, L., 2:56646
Miura, R., *See* Nakamura, K., 2:56558
Miyaev, N.A., *See* Balashov, N.A., 2:56994
Miyakawa, T., *See* Yoshimoto, Y., 2:56702
Miyazaki, N., *See* Yagawa, G., 2:56690
Miyazono, S., Fatigue behavior of nozzles of light water reactor pressure vessel model, 2:56387
Mizobuchi, S., *See* Kanoh, S., 2:56496
Mizuno, N., Experimental and analytical studies for a BWR nuclear reactor building: evaluation of soil-structure interaction behavior, 2:56398
Mlavsky, A.I., *See* Ravi, K.V., 2:56061
Mochan, S.I., *See* Mitor, V.V., 2:56316
See Tyntarev, E.M., 2:56322
Moeller, D.W., Estimation and control of population dose within buildings, 2:57432
Moessbauer, R.L., German-British-French high flux reactor in Grenoble and its research program, 2:56762
Moiseeva, L.N., *See* Mitor, V.V., 2:56316
Mokler, P.H., Experimental evidence for anisotropy of non-characteristic x-rays, 2:57542
Mol, M., *See* Kottowski, H.M., 2:56607
Molz, F.J., Experimental study of the subsurface transport of water and heat as related to the storage of solar energy, 2:56166
Monsler, M.J., *See* Maniscalco, J.A., 2:57775
Montanari, M., *See* Cumo, M., 2:56395
Montano, J.W.L., The stress corrosion resistance and the cryogenic temperature mechanical properties of annealed Nitronic 60 bar material, 2:57115 (N—77—16149)
Moody, B.E., Gasification of hydrocarbon feedstocks, 2:55985
Moody, D.C., Novel co-ordination of sulphur dioxide. The crystal and molecular structure of nitrosyl(sulfur dioxide)bis(triphenylphosphine)rhodium, 2:57233
Moon, F.C., Lateral buckling and vibrations of superconducting magnets for magnetic fusion reactors. Progress report, October 1976—May 1977, 2:57731 (COO—2780-3)
Moore, C.F., High-resolution x-ray and Auger electron measurements in ion-atom collisions, 2:57541
Moore, C.S., Analytical and experimental treatment of a spray-on selective coating: application to collector design, 2:56140
Moore, D.F., *See* Quincy, E.A., 2:55591
Moore, L.P., *See* Winans, R.E., 2:55636
Moore, P., Metricating the crude oil and natural gas industry, 2:55703
Moore, S.E., Contributions of the ORNL piping program to nuclear piping design codes and standards, 2:56662
Moran, J., *See* Melfi, S.H., 2:57366
Moran, K.E., Rotor for wind-driven machine, 2:56223
More, R.M., *See* Spitznagel, J.A., 2:57149
Moreau, B., *See* Gandrey, L., 2:56421, 2:56422
Morelle, L., *See* Reynen, J., 2:56383
Morgan, G.R., *See* Mitchell, R.C., 2:56156
Morgan, K.Z., Non-ionizing radiation protection training manual for radiation control. Lectures, demonstrations, laboratories and tours on the course on non-ionizing radiations. Final report, 2:57431 (PB—264888)
Morgan, M.A., Simultaneous influx and efflux of nitrate during uptake by perennial ryegrass, 2:57418
Morgan, M.G., Individual air pollution monitors. 2. Examination of some nonoccupational research and regulatory uses and needs, 2:57352 (BNL—50637)
Morgan, W.C., Feasibility of monitoring the strength of HTGR core support graphite: Part I, 2:56427 (BNWL—2239)
Morgan, W.S.G., Fishing for toxicity: biological automonitor for continuous water quality control, 2:57396
Morgenstern, R., Electron ejection in slow heavy particle collisions, 2:57535
Morisawa, J., *See* Shibato, E., 2:56466
Morovskii, A.V., *See* Landa, G.R., 2:56324
Moroz, V.I., *See* Mukhin, L.M., 2:57490
Morozov, D.I., Calculation of the motion of a medium in schematized elements of turbine ducts, 2:56331
Morris, B., *See* Austin, L.G., 2:55642
Morris, C.J., Code to assist in teaching nuclear fuel management, 2:56622
Morris, G.A., Methane formation in tritium gas exposed to stainless steel, 2:55968 (UCRL—52262)
Morris, M.D., Designs for the detection of inadequacy in factorial models, 2:57813 (ORNL/CSD/TM—30)
Morris, S.C., *See* Morgan, M.G., 2:57352
Morrison, G., *See* Jackim, E., 2:57447
Morrissey, D.J., *See* Hulet, E.K., 2:57601
See Loveland, W., 2:57604
Mortenson, S.C., Transient behavior of HTGR fuel particles, 2:56433
Mosher, D., *See* Young, F.C., 2:57652
Mosteller, R.D., Incorporation of commercial reactor codes into a nuclear engineering course, 2:56621
Mostepanenko, V.M., *See* Mamaev, S.G., 2:57488
Motoda, H., Reactor control system, 2:56736
See Kiguchi, T., 2:56698
Mott, J.E., *See* Ackermann, N.J. Jr., 2:56364
Mouchina, E.A., *See* Krentsel, B.A., 2:55773
Mowrey, G.L., *See* Hardy, H.R. Jr., 2:55657
Mrochek, J.E., New portable centrifugal fast analyzer with expanded versatility, 2:57201 (CONF-770332—1)
Mueller, A., *See* Badur, A., 2:56804
Mueller, E., Dustfree removal of electrically filtered flyash experiences with screening, 2:55651
Mueller, G., *See* Froehlich, G., 2:56868
Mueller, K., Natural-gas liquefaction by an expansion-turbine mixture cycle, 2:55813
Peak-shaving with Groningen natural gas, 2:55812
Mueller, K.G., *See* Martin, C., 2:57654
Mueller, W.F., *See* Kuschel, D., 2:56393
Mukherjee, D.K., Cooling of gas turbines blades, 2:56263
Film cooling with injection through slots, 2:56311
Pressure loss coefficient of impingement cooled leading edge system of a turbine blade, 2:56308
Mukherjee, S., *See* Lance, R.H., 2:57110
Mukhin, L.M., Early evolution of the terrestrial atmosphere and hydrosphere, 2:57490
Mukhina, M.P., *See* Kutasov, R.F., 2:56268
Mundkur, P., *See* Liu, M., 2:57357
Munir, Z.A., *See* Lam, S.T., 2:57154
Munis, R.H., Detecting structural heat losses with mobile infrared thermography. Part III. Survey of USA CRREL, 2:57003 (NP—22267)
Mura, P., *See* Bernardini, C., 2:56121
Murbach, E.W., *See* Darr, D.G., 2:55937
Murphy, C.E. Jr., *See* Watts, J.R., 2:57382
Murphy, D.J. Jr., Performance calculations of fast reactor actinide recycle as a waste management alternative, 2:55926
Murphy, L.M., Coming: solar power plants, 2:56087
Tower design considerations for the solar thermal central receiver systems, 2:56086 (SAND—77-8243)
Murray, P., *See* Livey, D.T., 2:57157
Murray, R.E., *See* Saperstein, L.W., 2:55684
Murzin, V.S., *See* Angelov, N., 2:57571
Musaelyan, A.G., Investigation of circulation and separation characteristics of a low-capacity high pressure boiler with external cyclone, 2:56323
Musgrave, B., *See* Barish, S.J., 2:57564
Musgrave, B.C., *See* Slansky, C.M., 2:55900
Mushiake, K., *See* Masuko, N., 2:56210
Mussio, P., *See* Garribba, S., 2:56866
Mustafin, Kh.Sh., Hydraulic calculation of hydroelectric power station spillways, 2:56006
Muszynski, Z., *See* Nakwaski, W., 2:57296
Muto, T., *See* Akutsu, H., 2:56710
Muzychuk, F.M., Utilization of phase-frequency characteristics in adjusting all-regime centrifugal regulators for experimental determination of their time constants, 2:57061

Muzzio, A., *See* Lorenzi, A., 2:57298
Myers, M., Tin and bismuth in lead—calcium alloy, 2:56906
Mysnik, A.I., *See* Akopin, V.D., 2:57569

N

Nabatova, N.A., Experimental investigation of the effect of frequency nonuniformity on the level of resonance vibrations of rotor blades, 2:56326
Nachlas, J.A., *See* DePorter, E.L., 2:55873
See Kurstedt, H.A. Jr., 2:55894
Nagata, T., *See* Nakamura, K., 2:56558
Naito, K., Containers for radioactive aerosols, 2:56571
Naito, Y., *See* Kihara, H., 2:56680
Nakacho, K., *See* Ueda, Y., 2:57262
Nakajima, N., *See* Miyazono, S., 2:56387
Nakajo, Y., Material manufacturing and fabrication of ultra-large size hydrodesulphurization reactors, 2:57263
Nakamura, K., Creep-fatigue test of an elbow subjected to cyclic in-plane moment loading, 2:56558
Nakamura, Y., *See* Kihara, H., 2:56680
Nakanishi, T., *See* Oda, N., 2:57077
Nakao, H., *See* Kanazawa, S., 2:57136
See Kunitake, H., 2:56385
Nakata, A.G., *See* DiCanio, D.G., 2:55732
Nakata, A.H., *See* DiCanio, D.G., 2:55733, 2:55734
Nakwaski, W., Technology and spectral characteristics of Polish heterojunction lasers, 2:57296
Naldi, F., *See* Garribba, S., 2:56866
Nandakumar, S., *See* Dixit, K.B., 2:56465
Nandi, S.P., *See* Roy, T.N., 2:55735
Nanis, L., *See* Kapur, V.K., 2:56039
Nappa, L.A., Nitrogenous substances of kerogen in Estonian dictyonemic shales, 2:55846
Narten, A.H., X-ray diffraction pattern and models of liquid benzene, 2:57553
Narukawa, S., *See* Ikeda, H., 2:56902
Nash, C.P., Isotope effects and spectroscopy, 2:57205
Nath, P., *See* Das, S.R., 2:56051
Nazareth, L., Davidon's optimally conditioned algorithms for unconstrained optimization, 2:57807 (ANL-AMD-TM—283(Rev.))
Relationship between the BFGS and conjugate gradient algorithms, 2:57806 (ANL-AMD-TM—282(Rev.))
Nazargulov, R.M., *See* Angelov, N., 2:57570, 2:57571
Nazarov, O.I., *See* Filippov, G.A., 2:56286
Nche, P., *See* Mcdermott, P., 2:56888
Neal, T., Determination of the Grueneisen γ for beryllium at 1.2 to 1.9 times standard density, 2:57113 (LA-UR—77-1292)
Nechaev, V.V., Calculation of the readiness of power plant equipment, 2:56284
Nechtschein, J., Study of chemical behavior of dispersant additives on metal surfaces: reaction of amide functions on aluminum oxide, 2:55774
Nedavnii, A.P., *See* Danileiko, M.V., 2:57290
Neef, W.S., *See* Bender, D.J., 2:57713
Neef, W.S. JR., Mechanical design aspects of a Tandem Mirror Fusion Reactor, 2:57712
Neill, W.H., Magnitude and ecological implications of thermal inertia in skipjack tuna, Katsuwonus pelamis (Linnaeus), 2:57444
Neilson, R.M. Jr., Immobilization of tritiated aqueous waste in polymer-impregnated concrete, 2:55905
Neimark, L.A., *See* Strain, R.V., 2:56475
Nelson, H.G., *See* Rao, D.B., 2:55548
Nelson, I.C., Plutonium in human lung in the Hanford environs, 2:57436 (BNWL-SA—5855)
Nelson, M.A., *See* Franks, L.A., 2:57309
Nelson, R.A., *See* Chen, Y.S., 2:56810
Nelson, R.S., Simulation of void swelling: a critical review, 2:56654
Nelson, R.W., Calculated and observed nonisothermal multiphase in flow in vertical columns, 2:57375 (ARH-SA—278)
Nemecek, J.J., Demand sensitive energy storage in molten salts, 2:56157
Nemoto, K., Reactor apparatus, 2:56573
Neshkov, P.F., *See* Nudel', A.M., 2:56686
Nettesheim, P., *See* Steele, V.E., 2:57453
Neubert, W., Analysis of excitation functions in (HI,xn) reactions on the basis of a simple evaporation model, 2:57617
Neugroschel, A., *See* Lindholm, F.A., 2:56071
Neutmin, V.M., *See* Usachev, I.P., 2:56325
Nevinskii, V.V., *See* Zysin, V.A., 2:57305
Nevskii, P.L., *See* Abramov, V.V., 2:57565
Newman, J., *See* Trainham, J.A., 2:57048
Ney, J.F., Surveillance and containment instrumentation international safeguards, 2:55962 (SAND—77-0980C)
Nicol, J.A.C., Chemical composition and effects of water extracts of petroleum on eggs of the sand dollar Melitta quinquiesperforata, 2:57448
Nicol, S.K., Selective agglomeration in the treatment of fine coal refuse, 2:55652
Niehaus, F., *See* Otway, H.J., 2:55941
Nielsen, S.O., Prospect of international cooperation on high-level-waste disposal on the ocean floor, 2:55929
Nieschmidt, E.B., *See* Dolan, C.A., 2:55965
Niessen, H.F., High temperature materials requirements in reforming of gaseous hydrocarbons with HTR heat, 2:56613
Nigmatulin, I.N., *See* Belyaev, V.I., 2:56365
Nikiforov, O.A., *See* Levkin, G.M., 2:57057
Nikitin, E.E., Non-adiabatic effects in collisional vibrational relaxation of diatomic molecules, 2:57532
Nikitin, M.D., *See* Bogdanov, B.I., 2:57054
Nikitin, Y.P., *See* Abramov, V.V., 2:57565
Nikitina, V.F., *See* Angelov, N., 2:57570, 2:57571
Nikki, T., *See* Kobayashi, H., 2:57217
Nikolaev, V.A., *See* Balandin, Yu.F., 2:56694
Nikolaev, V.S., Study of K, L, and M inner-shell ionization by proton impact, 2:57539
Niland, P., *See* Aitken, D.W., 2:56021
Nilson, R.H., *See* Hardee, H.C., 2:56801
Nilsson, F., Model for fracture mechanical estimation of the failure probability of reactor pressure vessels, 2:56673
Ninacs, G.J., *See* Fraser, D.B., 2:56932
Ninomiya, H., Positional instabilities of a plasma in a tokamak with a magnetic limiter, 2:57737
Nishi, M., *See* Fujino, M., 2:56399
Nishida, Y., *See* Urakami, K., 2:56183
Nishimaki, K., Stress analysis of partial sphere used for bottom shell of off-shore structure, 2:56691
Nishimiya, T., Air-fuel ratio regulating apparatus for an internal combustion engine with exhaust gas sensor characteristic compensation, 2:57081
Nitschke, J.M., *See* Hulet, E.K., 2:57601
Nivy, S., *See* Slor, H., 2:57433
Nobbee, C., *See* Chan, W., 2:56114
Noble, J.B., Environmental planning and the siting of nuclear facilities: the integration of water, air, coastal, and comprehensive planning into the nuclear siting process. Improving regulatory effectiveness in federal/state siting actions, 2:56582 (NUREG—0199)
Noetzold, D., Computational simulation of shock-induced gas-phase reactions, 2:57247
Nohgata, H., *See* Shikoh, S., 2:57261
Nordahl, J.H., *See* Waymire, G.R., 2:57279
Nordio, M., *See* Marena, M., 2:56610
Norov, E.Zh., Experimental investigations of solar distilling installations with different film surfaces, 2:56118
Notis, E.M., *See* Pinter, T.G., 2:57335
Novakov, T., Atmospheric aerosol research. Annual report, 1975—1976, 2:57355 (LBL—5214)
Novash, V.I., computational experiment in the investigation of electromagnetic transient processes in electric power transmission lines, 2:56352
Noviello, C., *See* Beretta, F., 2:57318
Novikova, L.P., *See* Savin, V.I., 2:57009
Novozhilov, V.Y., *See* Volkonskii, N.Y., 2:57574
Nowak, H.D., *See* Bahre, K., 2:55676
Nowicki, J.A., *See* Spier, E.M., 2:56411
Noyes, R.M., *See* Field, R.J., 2:57215
Nozdrenko, G.V., Utilization of exergy function in mathematical modeling of thermal power plants, 2:56233
Nozzi, P., *See* Cumo, M., 2:56395
Nuckolls, J.H., *See* Ahlstrom, H.G., 2:57771
Nudel', A.M., Experience of industrial operation of wash-in cartridge filters in chemical water purification schemes of nuclear power plants, 2:56686
Nurushev, S.B., *See* Akopin, V.D., 2:57569
Nuss, C., Automobile acceleration control for fuel economy, 2:57082
Nussbaumer, D.A., Regulation of naturally occurring and accelerator-produced radioactive materials. A Task Force review, 2:57430 (NUREG—0301)
Nuttli, O.W., Evaluation of earthquake hazard in the central Mississippi Valley, 2:56744
Nybo, R., North Sea offshore loading, what is the problem, 2:55799

O

O'Brien, F.D., *See* Kanter, M.A., 2:56623
O'Connell, J.S., *See* Berman, B.L., 2:57612
O'Dell, L.D., Comparison of 2D and 3D diffusion theory codes for transition-phase modeling of distorted subassemblies, 2:56778 (HEDL-TME—77-26)
O'Fallon, N., *See* Duffey, D., 2:57192
O'Neill, B.E., *See* Szyliowicz, J.S., 2:56969
O'Reilly, E.J., *See* Woolsey, N.F., 2:55620
O'Reilly, P., Assessment of CRBRP containment response to a hypothetical core melt-through accident, 2:56833
Oakes, T.W., Concentrations of radionuclides and selected stable elements in fruits and vegetables, 2:57381 (CONF-770676—1)
Obeng, L., Should dams be built. The Volta Lake example, 2:56013
Obmoin, V.V., *See* Shelud'ko, L.P., 2:56271
Ochiai, K., *See* Yoshimoto, Y., 2:56702
Ochkin, V.N., *See* Volchenok, V.I., 2:57295
Oda, A., *See* Kamiya, K., 2:56402
Oda, N., Apparatus for generating high-pressure gas, 2:57077
Odaka, S., *See* Hirota, S., 2:56179
Odegard, B.C., *See* Saxton, H.J., 2:57208
Oelkers, E., *See* Heller, A.S., 2:56864
Offenhartz, P.O., Chemical methods of storing thermal energy, 2:56155

Oftedahl, O.G., *See* Schopf, J.M., 2:55647
Ogino, T., *See* Sanuki, H., 2:57679
Ogorodnikov, S.N., *See* Babkin, G.V., 2:57658
Oguchi, I., *See* Shibato, E., 2:56466
Oguma, M., *See* Saito, K., 2:56719
Ogurtsov, G.N., Auger transitions in the quasimolecule $Ar^+ + Ar$, 2:57516
Decay of autoionization states in collisions of heavy atomic particles, 2:57509
Ohanian, E.V., Genetic influence on hypertension induced by cadmium in Dahl hypertension-resistant and hypertension-sensitive rats, 2:57427
Ohkawa, Y., *See* Matsumura, M., 2:56556
Ohmine, S., *See* Austin, L.G., 2:55642
Oizon, R., Geography of energy production in France. IV. Natural regions: the inland north and Lorraine, 2:55664
Oka, Y., Experimental study on fast-neutron streaming through a grid-plate shield of a liquid-metal fast breeder reactor, 2:56564
Okabayashi, K., *See* Hasegawa, M., 2:56540
See Nakamura, K., 2:56558
Okabayashi, M., *See* Davis, S.L., 2:57632
Okazaki, I., *See* Kamada, K., 2:56900
Oki, Y., *See* Hirota, S., 2:56180
Okolovich, V.N., *See* Ignatyuk, A.V., 2:57600
Okrent, D., Safety studies of second-generation fusion reactor designs, 2:57761
See Badham, V., 2:57745
See Chan, C.K., 2:56830
See Chien, S.H., 2:56800
See Hsieh, T., 2:56789
See Mortenson, S.C., 2:56433
See Solomon, K.A., 2:57458
See Steele, W.G., 2:56799
See Villolobas, A., 2:56707
Okula, K., *See* Conn, R.W., 2:57791
Ol'khovskii, G.G., Method of measurement for thermal tests of the GT-100-750-2 LMZ (Leningrad Metal Works) gas turbine power plant, 2:56333
Thermal tests of a GT-35 gas turbine unit operating in a steam and gas turbine power plant with a high-pressure boiler, 2:56288
Oland, C.B., *See* Greenstreet, W.L., 2:55583
Olander, D.R., Particle cavitation during hydrogen reduction of mixed-oxide fuel, 2:55871
Olds, F.C., Britain's prototype fast reactor: key to the commercial FBR systems, 2:56552
Olins, A.L., ν bodies are close-packed in chromatin fibers, 2:57412 (CONF-770648—2)
See Zama, M., 2:57411
Olins, D.E., *See* Zama, M., 2:57411
Olivain, J., *See* Gervais, F., 2:57677
Olivet, J., *See* Gouguel, J., 2:56173
Olmos, J., Modular approach to fault tree and reliability analysis, 2:56867
Olsen, D.K., *See* Difilippo, F.C., 2:57606
Olson, D.L., Corrosion of ferrous alloys in nitrogen contaminated liquid lithium, 2:57133 (CONF-760503—P1, pp 446-452)
Olson, W.H., *See* Holmes, J.T., 2:56479
Olszewski, J.S., B and W-designed close-spaced fuel storage racks, 2:56412
Olszowka, J., *See* Sablik, J., 2:55716
Omata, I., Layering and combustion in the HTGR containment following depressurization accident, 2:56803
Omberg, R.P., *See* Haffner, D.R., 2:56547
Oneda, S., *See* Slaughter, M.D., 2:57586
Onega, R.J., Computer modules in the nuclear engineering laboratory, 2:56620
Onishi, Y., Finite element models for sediment and contaminant transport in surface waters. Transport of sediments and radionuclides in the Clinch River, 2:57398 (BNWL—2227)
Ono, A., Temperature and pressure of the Ryoke gneisses estimated by garnet-cordierite geothermometer, 2:56214
Onuki, Y., *See* Kihara, H., 2:56680
Openshaw, F., *See* Russell, J.L. Jr., 2:56079, 2:56088
Orbon, S.J., *See* Shiels, S.A., 2:56524
Orlik, V.G., *See* Kosyak, Yu.F., 2:56252
Orlov, A.N., *See* Karlov, N.V., 2:57292
Orlov, R.V., *See* Babkin, G.V., 2:57658
Orphan, V., *See* Gozani, T., 2:57191
Orphan, V.J., *See* Rundquist, D.E., 2:57307
Ortenblad, B., *See* Brolin, T., 2:57046
Osasyuk, V.V., *See* Efimenko, G.P., 2:56289
Oshchepkova, T.B., *See* Zinger, N.M., 2:57010
Osokin, G.F., *See* Terekhova, A.I., 2:57041
Ostensen, R.W., Role of fission gas in development of the transition phase, 2:56841
Ostroumov, V.I., *See* Ivanov, N.A., 2:57153
Ostrovskii, Yu.I., *See* Bavel'skii, D.M., 2:56314
Otoguro, Y., *See* Kanazawa, S., 2:57136
Otomo, T., *See* Honma, K., 2:56783
Ots, A.A., Combined method of cleaning boiler heating surfaces, 2:56306
Ottesen, D.K., *See* Green, R.M., 2:56154
Otto, P., *See* Gebelein, H., 2:56353
Otto, R.J., *See* Hulet, E.K., 2:57601
See Loveland, W., 2:57604
Otway, H.J., Risk estimation, evaluation, and management, 2:55941
Ouzounian, G., *See* Michard, G., 2:56193
Ovechkin, N.F., *See* Umarov, G.Ya., 2:56095, 2:56134
Owen, R.D., Studies in developmental immunogenetics. Annual progress report, 2:57406 (CALT—767P6-X12)
Oyegbesan, A.O., Investigation of a turbulent free-jet flame with chemical unbalance, 2:55976
Ozawa, Y., *See* Naito, K., 2:56571

P

Paddock, J.L., *See* Agmon, T., 2:56917
Paderin, L.Ya., Compound concentrators with spherical radiation sources, 2:56132
Padrick, T.D., Performance characteristics of the Sandia atomic iodine laser (SAIL-1), 2:57284 (SAND—76-9300)
Pai, D.H., Design considerations of the Clinch River Breeder Reactor Plant intermediate heat exchanger, 2:56557
See Chern, J.M., 2:56554
Pailer, M., High-sulfur shale oils. VII, 2:55849
Painter, L.R., *See* Heller, J.M. Jr., 2:57221
Palagin, A.A., Automation of drawing and graphic work in turbine construction, 2:56339
Palei, V.A., *See* Arkad'ev, B.A., 2:56664
Palmer, M.A., *See* Padrick, T.D., 2:57284
Palmer, N.I., Current trends in battery separators, 2:56904
Palmer, R.E., *See* Padrick, T.D., 2:57284
Palmer, R.S., *See* Stauffer, T.R., 2:56553
Pana, P., Calculation of the stationary mass velocity of steam mixtures and of the recoil forces occurring during LOCA, 2:56780 (IRS-W—24)
Pande, C.S., Mechanism for the degradation of superconducting transition temperatures on high energy neutron radiation in A-15 compounds, 2:57125 (BNL—23053)
Panisko, F.E., *See* Meyer, R.O., 2:56722
Panke, H., *See* Betz, H.D., 2:57543
Pankina, R.G., *See* Maksimov, S.P., 2:55742
Pankove, J.I., Photoluminescence of hydrogenated amorphous silicon, 2:57178
Panteleev, S.V., *See* Voitovich, A.P., 2:57288
Papmahl, F., *See* Backhaus, H., 2:55810
Paramonov, V.I., *See* Balinov, I.M., 2:55670
Parfenov, Y.V., *See* Vall, A.N., 2:57580
Pariseau, W.G., Thermoelastic analysis of waste-container sleeve: I. Initial estimates of loading on the sleeve. Technical memorandum report (RSI-0010), 2:55910 (ORNL/SUB—3706/6)
Thermoelastic/plastic analysis of waste-container sleeve: III. Influence of salt strength on sleeve loading. Technical memorandum report (RSI-0018), 2:55911 (ORNL/SUB—4269/2)
Thermoelastic/plastic analysis of waste-container sleeve: IV. Air gap influence on hole closure. Technical memorandum report (RSI-0019), 2:55912 (ORNL/SUB—4269/3)
See Ratigan, J.L., 2:55914
Parish, T.A., Initial neutronic evaluation of imploding liner fusion reactor blankets for transmuting fission products, 2:57796
See Hwang, W.G., 2:57741
Park, U.Y., *See* Kohn, H.W., 2:56373
Parker, D.G., Permeability of fly ash and fly ash stabilized soils. Final report on highway research project no. 47, 2:55648 (PB—265229)
Parker, F.G., *See* Ray, S.S., 2:55649
Parker, R.O., *See* Reisman, O.I., 2:56643
Parker, R.R., Low Z/sub eff/ tokamak operation, 2:57721
Parkinson, T.F., *See* Onega, R.J., 2:56620
Parmentier, C., *See* Lievens, F., 2:56400
Parr, T.P., Crossed molecular beams kinetics: BaO recoil velocity spectra from $Ba + N_2O$, 2:57511
Parrish, W.R., *See* Jones, M.C., 2:56360
Parry, H.L., *See* Zaloudek, F.R., 2:56236
Parshin, A.A., Development of steam generator construction at the Taganrog Krasnyy Kotelshchik plant in the tenth five-year plan period, 2:56310
Gas and fuel oil boiler unit for an 800 mW power block, 2:56321
Raising the reliability of boiler units by improving the quality of welding of the heating surfaces, 2:56273
Parshutina, R.A., Technical re-equipment of nuclear power engineering and boiler engineering plants, 2:56666
Pasto, A.E., Synthesis and fabrication of EuB_6, 2:56726
Paton, B.E., New and advanced technological process of manufacture of connecting pipes on frames of nuclear power plants by electroslag welding, 2:57097
Patricelli, F., *See* Verbinski, V.V., 2:55714
Patwardhan, V.M., *See* Dixit, K.B., 2:56465
Paul, D., Angular correlation of electrons coming from ionization by electron impact, 2:57527
Paulet, J., *See* Espitalie, J., 2:55746
Pavlov, I.M., *See* Terekhova, A.I., 2:57041
Pavlovskaya, V.V., *See* Aleksandrov, Y.A., 2:57562
Payne, P.R., Aeolian windmill, 2:56224
Pean, Y., *See* La Villa, F., 2:55827
Pearlman, J.S., Charge separation and target voltages in laser-produced plasmas, 2:57651
Pearson, R.L., Interaction of LaC_2 and NdC_2 with SiC in HTGR particles, 2:56428 (CONF-770708—5)
See Lindemer, T.B., 2:56446

Pecha, P., Operational reliability evaluation of fast power reactor cores, 2:56569
Pechin, W.H., Cost of controlling inorganic chemical releases from LWR fuel fabrication plants, 2:55936
Pecinka, L., *See* Dach, K., 2:56425
Pecqueur, M., Transfer of technology in the French—Iranian study for a nuclear research center in Iran, 2:56637
Peelle, E., Ultimate trade-off problem: comparative social impacts of electrical energy alternatives, 2:57405
Peer, V.A., District heating in the Czechoslovakian energy balance, 2:56911
Technical development of district heating in the German Democratic Republic, 2:56342
Pegg, D.J., *See* Griffin, P.M., 2:57219
Peierls, R., Decaying states, 2:57619
Pekarsky, M.I., Time series analysis and forecasting applied to ANL TREAT experiments, 2:56815
Pekker, Ya.L., Determination of balance temperatures along the gas tract of the boiler by means of reduced fuel characteristics, 2:57323
Pellonpaa, C.V., *See* Fletcher, P.B., 2:56941
Pelto, P.J., Risk assessment method for nuclear fuel cycle operations, 2:55943
Penai, S., Pumped storage hydroelectric plants, 2:56885
Pendergrass, J., *See* Devaney, J., 2:57764
Penev, V.N., *See* Angelov, N., 2:57571
Penland, J.R., Use of reliability in the LMFBR industry, 2:56771 (CONF-770625—3)
Penn, W.J., CANDU fuel: power ramp performance criteria, 2:56460
Perekal'skii, A.F., *See* Balashov, N.A., 2:56994
Perey, F.G., Data covariance files for ENDF/B-V, 2:57622 (ORNL/TM—5938)
Perez, R.B., *See* Difilippo, F.C., 2:57606
Perkins, W.C., Nuclear safety of the ten-well insert for the SRP fuel element dissolver, 2:55880 (DP—1429)
Perret, F.L., Criteria for assessing radioactive waste management schemes, 2:55953
Perryman, E.C.W., Technology transfer: its contribution to the Canadian nuclear industry, 2:56633
Pershin, V.G., *See* Viksman, A.S., 2:57058
Persson, K.B., *See* de Hoog, F.J., 2:57287
Peselev, M.P., *See* Dubovskii, I.E., 2:56307
Peters, H.M., Preprints of the 1976 coal chemistry workshop, 2:55630 (CONF-760885—)
Peters, W.H., *See* Smith, C.W., 2:57256
Petersen, K., *See* Kasper, K., 2:56445
Peterson, G.R., *See* Holmes, J.M., 2:55558
Peterson, R.E., *See* Mar, H.Y.B., 2:56126
Peterson, R.W., Transportation status and problems in the back end of the fuel cycle, 2:55889
Petrie, T.W., Plasma rotations induced by 3.5-MeV alpha-particle losses, 2:57645
Petrosian, V., *See* Langer, S.H., 2:57482, 2:57483
Petrov, A.S., *See* Levin, M.I., 2:57019
Petrov, Y.N., *See* Karlov, N.V., 2:57292
Petrovic, K., Correlation between the content of n-paraffins and some basic properties of diesel fuels, 2:55777
Petrukhin, A.A., *See* Borog, V.V., 2:57596
Petterson, B.J., *See* Thacher, P.D., 2:56023
Pettit, R.B., Specular reflectance properties of mirror materials, 2:56149
Petukhov, V.P., *See* Nikolaev, V.S., 2:57539
Petukhov, Yu.I., *See* Gruzdev, N.I., 2:56379
Pevgov, V.G., *See* Karlov, N.V., 2:57294
Pfannkuch, H.O., *See* Riaz, M., 2:56159
Pfefferle, W.C., Method of starting a combustion system utilizing a catalyst, 2:57086
Pfenninger, H., Experience with gas turbines fired with blast-furnace gas, 2:56267
Phan-Ngoc, K., Benefit of using a global tridimensional finite element calculation for the analysis of the primary part of a PWR steam generator, 2:56418
Phillips, C.R., *See* Siu, S.K., 2:55793
Phillips, J., *See* Meakin, J.D., 2:56070
Phillips, P.H., *See* Harris, G.S., 2:56955
Phillips, S.L., *See* Herr, J.J., 2:56169
Phillips, W.A., *See* Robison, W.L., 2:57437
Phung, D.L., *See* Whittle, C.E., 2:56741
Pian, C.C.P., Velocity and temperature distributions of coal-slag layers on magnetohydrodynamic generator walls, 2:56997 (N—77—16445)
Picraux, S.T., Low concentration oxygen depth profiling by the $^{16}O(d,\alpha)^{14}N$ reaction, 2:57190 (SAND—77-0424C)
Plir, A.E., Efficiency of production of heat and electric power at heat-and-power central stations, 2:56234
Pilati, D.A., Energy savings via behavioral changes, 2:56947
Pinder, K.L., *See* Basu, D.K., 2:56648
Pindyck, R.S., International comparisons of the residential demand for energy: a preliminary analysis (World Oil Project), 2:56952 (PB—265108)
Pines, A., Application of novel NMR techniques to coal structure, 2:55640 (CONF-760885—, pp 229-232)
Pinkhasik, M.S., Measurement of excess oxidizer ratio in MHD generator combustion products, 2:56993
See Balashov, N.A., 2:56994
Pinter, T.G., Users guide to finger, thumb, and triple axis real time experiment control programs, 2:57335 (IS—4169)
Pinto, S, *See* Taube, M., 2:56388
Pipkin, F.M., *See* Auer, I.P., 2:57567
Piqueras, J., *See* Martinez, J., 2:56056
Pis'man, B.Ya., Development and tests of a condenser/degasser designed by VTI for special water purification systems of nuclear power plants, 2:56681
Pisano, D.J., *See* Griffin, P.M., 2:57219
Pisarenko, V.S., *See* Shastin, E.G., 2:56275
Pitchford, A.C., Steam treatment of sulfur-containing heavy crude oil or oil residue with a combination catalyst comprising a hydrogenation-desulfurization catalyst and an overbased jet fuel containing an alkaline earth or alkali metal alkyl phenol complex, 2:55768
Pitner, A.L., *See* Basmajian, J.A., 2:56724
See Birney, K.R., 2:56723
Pitt, W.W. Jr., *See* Jolley, R.L., 2:57388
Pittenger, L.C., *See* Berkner, K.H., 2:57798
Pitts, O.P. Jr., Nuclear inventory and management system (NIMS): a program for nuclear fuels accounting, 2:56605
Pizzica, P.A., Comparison of the EPIC and PLUTO computer codes for TOP conditions, 2:56825
Plaksin, O.T., *See* Shnitser, I.N., 2:57319
Plasil, F., Fusion in Kr-bombardments of medium-mass nuclei, 2:57597 (CONF-770115—1)
Plavinskii, A.I., *See* Pinkhasik, M.S., 2:56993
Plein, H.G., *See* Carlson, G.A., 2:56838
Plotnikov, V.P., *See* Zelenskii, V.G., 2:57124
Polak, V., Effect of pressure loss components on dynamic stability of water-steam mixture flow in once through steam generator channel, 2:56688
Pollack, H.N., Flow of heat from the Earth's interior, 2:56206
Pollard, W.G., *See* Whittle, C.E., 2:56741
Polosukhina, N.S., CH lines in the spectrum of the magnetic variable 73 Draconis, 2:57481
Polovov, V.M., *See* Vinnikov, L.Y., 2:57162
Polvanich, N., *See* Kobayashi, A.S., 2:56658, 2:56672
Polyakov, V.I., *See* Krasnoyarov, N.V., 2:56481
Polyanskii, E.A., *See* Belyaev, V.I., 2:56365
Pomeroy, P.W., Problems of seismic risk analysis in the Northeast United States, 2:57468
Pomraning, G.C., *See* Badham, V., 2:57745
See Okrent, D., 2:57761
Poole, A.D., *See* Whittle, C.E., 2:56741
Poole, D.R., *See* Huxtable, D.D., 2:56162
Pope, J.M., *See* Radford, K.C., 2:55875
Pope, R.B., LMFBR spent fuel transportation technology development, 2:57280
Poplavskii, I.V., *See* Malyarov, V.V., 2:57590
Popov, E.F., Characteristics of a control disk throttle with a limited angle of swivel, 2:56319
Popov, V.G., *See* Paton, B.E., 2:57097
Popov, V.L., Improvement of designs of sets for preparatory workings in Moscow basin conditions, 2:55702
Popova, V.M., *See* Angelov, N., 2:57570, 2:57571
Popushoi, M.N., *See* Malyarov, V.V., 2:57590
Popyrin, L.S., Power industry of Siberia in the tenth five-year plan period, 2:55665
Porges, K.G., *See* Duffey, D., 2:57192
Porto, J., Generator of reactivity functions, 2:56640
Posadskaya, A.S., *See* Dal'yan, I.B., 2:55751
Postoev, V.S., Manufacture of multi-layered casings of stationary apparatus and problems of their strength, 2:56695
Postolovskii, S.N., Method of improving operating efficiency of blow fans and exhaust fans of the 0.55-40-1 type, 2:57039
Potanina, M.I., *See* Postolovskii, S.N., 2:57039
Potapov, A.V., *See* Babkin, G.V., 2:57658
Potter, D.I., *See* Agarwal, S.C., 2:57151
Potter, R.W. II, Volumetric properties of aqueous sodium chloride solutions from 0° to 500°C at pressures up to 2000 bars based on a regression of available data in the literature, 2:56208 (USGS-BULL—1421-C)
Potter, T., Probabilistic prediction of X/Q for routine intermittent gaseous releases, 2:57373
Potylitsin, A.P., *See* Kuznetsov, V.M., 2:57572
Povarov, O.A., *See* Filippov, G.A., 2:56286
Povolotskii, L.B., *See* Ol'khovskii, G.G., 2:56288
Powell, F.P., *See* Woodhall, C.B., 2:55890
Powell, J., Liquid-wall boiler and moderator (BAM) for heavy ion-pellet fusion reactors, 2:57793
See Hsieh, S.Y., 2:57735
See Lazareth, O., 2:57746
Powell, J.R., MAXAMAK and MULTIMAK: new approaches for tokamak power reactors, 2:57715
Safety of large fusion magnet systems, 2:57732
See Beardsworth, E., 2:57702
See Botts, T., 2:57762
See Fillo, J.A., 2:57727, 2:57729
See Steinberg, M., 2:55906
Powers, J.H., Alcoa 655 selective surface for aluminum, 2:56139
Poznyakov, G.G., *See* Batmanov, Yu.K., 2:55738

Prasad, K.N., Assessment of the consequences of boiling in the radial blanket due to hypothetical major pipe leaks, 2:56827
Pratt, W.T., *See* Bari, R.A., 2:56828
Prausnitz, J.M., Dew points of hot gases from coal gasification processes. Quarterly report, June 1—August 31, 1976, 2:55571 (FE—2046-1)
Dew points of hot gases from coal gasification processes. Quarterly report, September 1—November 30, 1976, 2:55572 (FE—2046-2)
Presnukhina, I.P., *See* Zhiglinskii, A.G., 2:57640
Pressler, J., *See* Koenne, W., 2:56351
Preston, R.K., *See* Walker, R.B., 2:57552
Price, M.S.T., *See* Lefevre, R.L.R., 2:56714
Price, W.G. Jr., *See* Gilligan, J.G., 2:57649
Prideaux, D.L., *See* Knecht, P.D., 2:56591, 2:56592
Prieve, D.C., *See* Brenner, H., 2:55600
Prikhod'ko, M.S., Layout of a scheme of combined diesel engine and turbine plants, 2:56246
Priseau, W.G., *See* Gnirk, P.F., 2:55908
Privalov, N.P., *See* Balashov, N.A., 2:56994
Privalov, V.E., *See* Melnikov, N.A., 2:57289
Proffitt, R., Some aspects of natural gas conservation, 2:57031
Prokhorov, A.M., *See* Karlov, N.V., 2:57292
Prokhorov, L.V., *See* Volkonskii, N.Y., 2:57574
Prokofichev, N.N., *See* Reznik, V.A., 2:55719
Prokop'eva, R.G., *See* Matusevich, V.M., 2:57477
Prokopenko, A.G., Warming-up of frames of double-walled medium-pressure cylinder of a K-300-240 turbine made by Kharkov Turbine Works, 2:56303
Proops, J.L.R., Input-output analysis and energy intensities: a comparison of some methodologies, 2:56919
Proshlyakov, B.K., *See* Kuznetsov, V.G., 2:55752
Proske, R., Contributions to the risk analysis of a repository for high-level radioactive wastes in geologic salt formations, 2:55923
Protsenko, A.D., *See* Lokshin, V.A., 2:56315
Prull, P.E., Method for extracting oil from oil shale, 2:55843
Pshenichnyi, V.D., *See* Popov, E.F., 2:56319
Puchkov, V.S., *See* Guzhov, N.P., 2:56232
Pugachev, A.L., *See* Gofaizen, A.V., 2:57302
Pugliese, S.M., Research safety vehicle program (Phase II) specification review. Volume II. Final technical report, Jul 1975—Nov 1976, 2:57073 (PB—264516)
Puigh, R.J., *See* Dyer, P., 2:57599
Purtyman, W.D., Geology and hydrology in the vicinity of the inactive uranium mill tailings pile, Ambrosia Lake, New Mexico, 2:55935 (LA—6839-MS)
Purvis, D.G., Evaluation of wet-head drilling techniques. Open file report, 2:55672 (PB—264997)
Pyasik, D.N., *See* Arkad'ev, B.A., 2:56318
Pyle, R.V., *See* Berkner, K.H., 2:57798
See Ruby, L., 2:57592
Pylev, I.M., *See* Busyrev, A.I., 2:56005
Pyun, J.J., *See* Majumdar, D., 2:56844

Q

Quan, V., Unified model for fission gas release and sodium boiling in reactor coolant channel, 2:56826
Quapp, W.J., Behavior of irradiated fuel rods during film boiling operation, 2:56808
Quemeneur, A., *See* Gervais, F., 2:57677
Quihillalt, O.J., Nuclear technology experience acquired by Argentina, 2:56636
Quincy, E.A., Remote sensing of an underground coal-burn cavity with a wide-band induction system, 2:55591
Quinet, J.L., *See* Benoist, E., 2:56487
Quinn, W.E., *See* Bartsch, R.R., 2:57661
Qvist, J., pH and haemoglobin oxygen affinity in blood from the antarctic cod Dissostichus mawsoni, 2:57442

R

Rabl, A., Prisms with total internal reflection as solar reflectors, 2:56147
Rachor, L., Spherical fuel element for high temperature reactors, 2:56452
Rack, E.P., *See* Berg, M.E., 2:57240
Radford, K.C., Ammonia as a sintering aid for UO_2, 2:55875
Radosevich, C.L., *See* Hollabaugh, C.M., 2:57164
Rago, W., *See* Silora, W., 2:55662
Rahman, S.F., Chemical and physical stability of refractories for use in coal gasification. First annual progress report, May 1, 1976—April 30, 1977, 2:55565 (COO—2904-4)
Rahn, R.O., Influence of Hg^{2+} on the excited states of DNA: photochemical consequences, 2:57408 (CONF-770346—1)
Rahnema, F., HTGR fuel failure in the absence of core cooling, 2:56802
Rai-Choudhury, P., *See* Hopkins, R.H., 2:56032
Rajakovics, G.E., Role of alkali metals in energy conservation, 2:56244 (CONF-760503—P1, pp 431-436)
Rakhmanov, A., Statistical investigation of the efficiency of solar and evaporative coolers in the conditions of Turkmenia, 2:56101
Ramain, P., Equivalence between electricity and fuels: elements for a critical discussion, 2:56960
Ramakumar, R., Assessment of hydrogen as a means to store solar energy, 2:56027
Ramani, R.V., *See* Saperstein, L.W., 2:55684
Ramaty, R., Al-26: a galactic source of gamma ray line emission, 2:57485 (N—77-16980)
Ramsey, R.R., Energy, environment, management, and systems, 2:56984
Rankin, D.W., Studies related to the seismicity of the Charleston-Summerville Area, South Carolina, 2:57470
Rao, D.B., Sulfidation of 310 stainless steel at sulfur potentials encountered in coal conversion systems, 2:55548 (N—76-31332)
Rard, J.A., *See* Spedding, F.H., 2:57214
Rassokhin, N.G., Nuclear power industry in the tenth five-year plan period, 2:56390
Ratay, R.P., Progress report for the Division of Safeguards and Security: July—December 1976, 2:55955 (MLM—2429)
Ratigan, J.L., Design aspects of the alpha repository: IV. Structural analysis of excavation geometries. Technical memorandum report RSI-0030, 2:55914 (ORNL/SUB—4269/11)
See Callahan, G.D., 2:55913
Ratliff, J.R., *See* Pitts, O.P. Jr., 2:56605
Ratman, J., Rubber pipe for hydraulic stowing, 2:55718
Ravi, K.V., EFG growth of silicon ribbon for solar cells, 2:56061
Rawley, C.J., *See* Spier, E.M., 2:56411
Rawls, J.M., *See* Hopkins, G.R., 2:57647
Ray, S.S., Characterization of ash from coal-fired power plants. Milestone report May 75-Mar 76, 2:55649 (PB—265374)
Ray, W.E., *See* Duke, J.M., 2:56505
Rayhun, J.L., *See* Brau, C., 2:57496
Razouk, R.R., Graph model of behavior simulator, 2:57821 (UCLA—34P214-42)
Rea, S.N., Large area Czochralski silicon for solar cells, 2:56064
Read, F.H., Energy exchanges between two escaping electrons, 2:57526
Reardon, P.J., TFTR: an overview, 2:57696
Rec, J.R., *See* Matzie, R.A., 2:56601
Reddy, D.P., *See* Werner, S.D., 2:56792
Reddy, V.N., *See* Kinsey, V.E., 2:57434
Redinger, I.H. Jr., External gas turbine engine cooling for clearance control, 2:57078
Redmond, R.F., *See* Kelly, K.A., 2:57424
Ree, F.H., *See* Isbell, W.M., 2:57118
Reed, J., *See* Gozani, T., 2:57191
Reed, L.D., *See* Gieseke, J.A., 2:56768
Reed, R.P., Stress waves measured and calculated for in situ explosive rubblization experiments in oil shale, 2:55832 (SAND—77-0779C)
Reed, W.H., *See* Bolstad, J.W., 2:56812
Reedy, G.T., *See* Green, D.W., 2:55867
Reeves, F., Space Processing Applications Rocket project, SPAR 1. Final report, 2:57093 (N—77—16082)
Rehbein, D.A., Effect of variable thermal conductivity in thermal-hydraulic calculations, 2:56875
Reich, T., Four-dimensional reconstruction of radioisotopic activity in the brain, 2:57420
Reichert, K., Present situation of the European Community coal mining industry, 2:56965
Reid, M.A., Factors affecting the open-circuit voltage and electrode kinetics of some iron/titanium redox flow cells, 2:57000 (ERDA/NASA/1002—77/10)
Reidelbach, H., *See* Noetzold, D., 2:57247
Reifsnider, K.L., *See* Subbaraman, G., 2:56518
Reiland, W., *See* Hertel, I.V., 2:57525
Reilly, J.T., Thermal radiation effects on subassembly wall failure in fast reactors, 2:56845
Rein, J.E., *See* Hollen, R.M., 2:57203
Reinhardt, J., *See* Betz, W., 2:57557
Reintjes, J., *See* Lehmberg, R.H., 2:57768
Reisman, O.I., Laminar heat transfer data with a step-varying wall heat flux, 2:56643
Reiter, M., Subsurface temperature data in Jemez Mountains, New Mexico. Circular 151, 2:56182 (NP—22280)
Terrestrial heat flow along the Rio Grande rift, New Mexico and southern Colorado, 2:56177 (PB—265038)
Reker, F.J., Ocean transport and storage of liquefied natural gas, 2:55823
Renfro, C.W., *See* Strain, R.V., 2:56475
Renner, T.A., Study of dimerization in acetonitrile vapor by measurement of thermal conductivity, 2:57231
Renzing, O., *See* Lanfermann, W., 2:55675

Reshed'ko, S.D., *See* Landa, G.R., 2:56324
Rest, J., Release of fission gas from high-burnup fuel during transient heating, 2:56372
Reucroft, P.J., Surface structure and mechanisms of gasification catalyst deactivation. Annual report, February 1976–January 1977, 2:55574 (FE—2229-4)
Reynen, J., Novel design for LWR pressure vessel nozzles and corresponding stress analysis, 2:56383
Reynolds, A.B., *See* Kennedy, M.F., 2:56821
Reznichenko, V.Ya., *See* Tyryshkin, V.G., 2:56313
Reznik, N.I., *See* Parshin, A.A., 2:56321
Reznik, O.A., *See* Shnitser, I.N., 2:57327
Reznik, V.A., Tests and aerodynamic probing of TSP2 cyclones with a louvered swirler, 2:55719
Reznik, V.I., Selection of thermal diagram of intermediate superheaters of gas and oil fuel-fired boilers, 2:56334
See Parshin, A.A., 2:56321
Rhee, S.J., Natural-convective cooling of a bed of fuel debris, 2:56834
Rhines, P.B., *See* Hollister, C.D., 2:55930
Rhodes, C.K., *See* Bischel, W.K., 2:57551
Riaz, M., High-temperature energy storage in native rocks, 2:56159
Ribe, F.L., Recent developments in the design of conceptual fusion reactors, 2:57693
Rice, D.W. Jr., *See* Harrison, F.L., 2:57446
Rice, S.A., Comparison of photoconductivity and optical spectra of the trapped electron in polar aqueous and alcoholic glasses, 2:57238
Richards, P., ^{132}Xe—^{132}I generator: a preliminary report, 2:57243 (BNL—22993)
Richardson, A.S., *See* Cox, N.D., 2:57036
Richardson, M.C., *See* Burnett, N.H., 2:57683
Richter, B., From the psi to charm: the experiments of 1975 and 1976, 2:57568
Richter, F., *See* Martin, C., 2:57654
Richter, G.N., *See* Slater, W.L., 2:55988, 2:55989, 2:55990
Richtmyer, T.E., *See* Hill, J.E., 2:56106
Rickard, W.H., Land rehabilitation research at Pacific Northwest Laboratories, 2:57387 (BNWL-SA—6089)
Riedel, H., Status report on environmental radioactivity monitoring in the Federal Republic of Germany, 2:57367 (STH—6/76)
Rikken, J., *See* Klesment, I., 2:55847
Riley, M.E., *See* Padrick, T.D., 2:57284
Riley, R.E., *See* Hollabaugh, C.M., 2:57164
Rinde, J.A., Fiber-composite flywheel program. Quarterly progress report, January—March 1977, 2:56886 (UCRL—50033-77-1)
Ring, P.J., *See* Spalaris, C.N., 2:56503
Ringle, J.C., *See* Hornyik, K., 2:56626
Rinne, R.L., Evaluation of safeguards systems for nuclear material in transit: the development of the program plan. Winter 1977 quarterly report, 2:55964 (SAND—77-8249)
Rippon, S., Enrichment prospects for the 1980's, 2:55865
Risley, J.S., Physics of electronic and atomic collisions, 2:57517
Ritter, A.I., Transmission electron spin resonance in dilute CuFe alloys, 2:57103 (COO—3150-39)
Ritzman, R.L., *See* Erdmann, R.C., 2:55945
Rivard, W.C., K-FIX: a computer program for transient, two-dimensional, two-fluid flow, 2:56785 (LA-NUREG—6623)
Roberts, D.M., Expanding nuclear engineering student knowledge horizons using the laboratory, 2:56618
Roberts, G.L., *See* Cox, J.L., 2:55555
Roberts, J.F., EBT time-dependent point model code: description and user's guide, 2:57628 (ORNL/CSD/TM—27)
Roberts, M.J., Derivation and testing of a model to calculate electrical shunting and leakage errors in sheathed thermocouples, 2:57342
Roberts, R.A., Coal gasification valves. Phase I. Thermal analysis report, 2:55579 (FE—2355-16)
Coal gasification valves. Phase I. Thermal analysis report, 8-inch, Types I, II, and IV valves, 2:55580 (FE—2355-19)
Roberts, R.W., U.S. experience in the transfer of nuclear technology, 2:56634
Robertson, C.G., Waste trench cap study of remedial work for West Valley, 2:55925
West Valley waste burial area problems correlated to operating practices, 2:55924
Robertson, S.R., *See* Marcus, P.A., 2:55757
Robin, A.M., Gasification of residual materials from coal liquefaction. Quarterly report, October—December 1976, 2:55611 (FE—2247-1)
Robin, P.L., Contribution of different chemical functions in the 1710, 1630, and 3,430 cm^{-1} infrared absorption bands of kerogens, 2:55845
Robinson, A.H., *See* Bossi, R.H., 2:57312
Robinson, D.N., Use of a modified beam in obtaining creep data in uniaxial tension and compression, 2:57109 (CONF-770807—8)
Robinson, F.P.A., *See* Thomas, C.R., 2:57138
Robinson, J.C., *See* Tomlinson, E.T., 2:56641
Robinson, J.E., *See* Behrisch, R., 2:57494
See Cafasso, F., 2:57789
Robinson, K.S., *See* Jones, T.B., 2:57770
Robinson, R.E., *See* Luce, R.G., 2:56988
Robison, W.L., Dose assessment at Bikini Atoll, 2:57437 (UCRL—51879(Pt.5))
Robozhev, A.V., Noise characteristics of reducing and cooling installations, 2:56243
Rocek, J., Physics calculations of A-1 type heavy water reactors, 2:56469
Roche, M., Computing methods for designing cathodic protection systems for elongate structures, 2:55798
Rochev, V.E., *See* Arbuzov, B.A., 2:57576
Rock, P.A., Electrochemical determination of equilibrium constants for isotope-exchange reactions, 2:57228
Isotopes and chemical principles, 2:57224
Rodnov, Y.V., *See* Abramov, V.V., 2:57565
Rodrigue, G.H., *See* Dubois, P.F., 2:57825
Rodriguez, R.G., *See* Smith, R.C., 2:55857
Roehr, H., Raman scattering: a possibility of calibrating laser scattering devices, 2:57641
Roehrig, H.D., *See* Fischer, P.G., 2:56441
Roehrig, S.C., Automatic duress alarms through physiological response monitoring, 2:55960 (SAND—77-0191)
Rogers, E.O., *See* Baker, M., 2:57583
Rogers, R.N., LASL methods for derivation of predictive models for explosives thermal hazards and lifetime, 2:57346 (LA-UR—77-1378)
See Loughran, E.D., 2:57345
Rogers, V.C., *See* Macbeth, P.J., 2:55940
See Sandquist, G.M., 2:55939
Rogov, K.D., *See* Nudel', A.M., 2:56686
Rogovoi, M.I., *See* Shubenko-Shubin, L.A., 2:56320
Rohde, K.L., *See* Slansky, C.M., 2:55900
Rohr, A., Line fault detectors for direct current railways, 2:57029
Rokahr, R.B., *See* Lux, K.H., 2:55828
Rollo, D., *See* Lim, C.B., 2:57422
Romanovsky, E.A., *See* Nikolaev, V.S., 2:57539
Romet, J.-L., *See* Faugeras, P., 2:56459
Romney, E.M., *See* El-Ghonemy, A.A., 2:57377
Roofthooft, R., Reports from water practice. The condensate purification system in the nuclear power plant at Doel, 2:56423
Rose, P.F., ENDF/B fission product decay data, 2:57588 (BNL-NCS—50545(Vol.1))
ENDF/B fission product decay data, 2:57589 (BNL-NCS—50545(Vol.2))
Rose, R.P., Fusion-driven actinide burner design study. Final report, 2:57755 (EPRI-ER—451(Vol.1)(5-77))
Fusion-driven actinide burner design study. Final report, 2:57756 (EPRI-ER—451(Vol.2)(5-77))
Rosebluth, M.N., *See* Waddell, B.V., 2:57662
Rosen, M.D., Radial boundary layers in diffusing toroidal equilibria, 2:57629
Rosenberg, B.J., *See* Wahl, A.C., 2:57501
Ross, D.S., *See* Peters, H.M., 2:55630
Ross, R.G. Jr., Design considerations of solar arrays for terrestrial applications, 2:56063
Rossing, T.D., *See* Kaminsky, M.S., 2:57803
Rosso, J.C., *See* Howland, J.W., 2:55767
Roth, H., Measuring vibration on turbine blades by optical means, 2:56266
Roth, R.D., *See* Flott, A.C., 2:57023
Rothman, A.J., *See* Lewis, A.E., 2:55837
Rothwarf, A., *See* Barnett, A.M., 2:56044
See Meakin, J.D., 2:56070
Rotty, R.M., Present and future production of CO_2 from fossil fuels: a global appraisal, 2:55656 (ORAU/IEA(O)—77-15)
See Whittle, C.E., 2:56741
Rouse, L.M., Review: silicon solar cells for terrestrial applications, 2:56045
Rouxhet, P.G., *See* Robin, P.L., 2:55845
Roy, T.N., Some studies in the prevention of spontaneous ignition of coals in stacks, 2:55735
Rozell, D.K., *See* Aitken, D.W., 2:56021
Rozenberg, S.Sh., *See* Kosyak, Yu.F., 2:56252
Rozenblyum, V.I., *See* Zysin, V.A., 2:57305
Rozenglat, M.Sh., *See* Shpil'rain, E.E., 2:56998
Rozhnov, G.V., *See* Abramov, V.V., 2:57565
Rozin, V.S., *See* Kirillov, I.I., 2:56272
Rubezhanskii, V.I., Stability of the replacement of a non-Newtonian fluid layer in a porous medium, 2:55765
Rubin, M., *See* Solomon, K.A., 2:57458
Rubin, M.P., Use of sulfur hexafluoride tracer techniques for near-stack dispersion studies, 2:57371
Rubinov, A.N., *See* Zaporozhchenko, V.A., 2:57291
Rubinstein, H.J., Spent fuel storage basis for new nuclear power plants, 2:55892
Ruby, L., Cross section for the production of ^{7}Be from ^{6}Li, ^{6}Li interactions, 2:57592
See Berkner, K.H., 2:57798
Ruderman, H., *See* Siri, W.E., 2:55956
Rudnik, A.G., Problems of technology of manufacture of hydraulic generator shafts and related consequences for assembly and operation of hydraulic units, 2:56011
Rudolph, J., Sensitive method for continuous air monitoring for ^{14}C and ^{3}H, 2:57374 (MLM—2441(TR))
Ruetten, H.J., *See* Schulten, R., 2:56442
Rukhlin, P.N., *See* Paton, B.E., 2:57097
Rundquist, D.E., Assessment of thick section radiography. Final report, 2:57307 (EPRI-NP—461)

Rus'kina, G.R., *See* Ignatyuk, A.V., 2:57600
Rusinek, H., *See* Reich, T., 2:57420
Russ, J.S., *See* Stein, N.A., 2:57566
Russell, J.E., *See* Gnirk, P.F., 2:55908
Russell, J.J., *See* Stein, N.A., 2:57566
Russell, J.L. Jr., Preliminary system analysis of a fixed mirror solar power central station. Final report, 2:56079 (EPRI-ER—434(6-77))
Preliminary system analysis of a fixed mirror solar power central station. Final report, 2:56088 (EPRI-ER—434)
Rust, K., *See* Malang, S., 2:56561
Rutkowski, M., Use of petroleum residues as binder in briquetting of coal, 2:55776
Ryabchenkov, A.V., Some questions of high-temperature vanadic corrosion and principal lines of development of heat-resistant materials, 2:57137
Ryabtsev, V.A., *See* Shpil'rain, E.E., 2:56998
Ryan, R.R., *See* Moody, D.C., 2:57233
Ryasheatseva, E.S., *See* Bochkarev, G.R., 2:55653
Rybal'chenko, L.F., *See* Yanson, I.K., 2:57267
Rybalko, V.K., Experimental investigation of residual fuel oil atomization by water injectors, 2:57320
Rybovalov, Yu.P., *See* Vasil'chenko, G.S., 2:56330
Ryndin, N.I., *See* Postoev, V.S., 2:56695
Ryti, M., Calculation of the non-steady gas exchange process in internal combustion engines, 2:57051
Ryzhkov, S.V., Investigation of drop settlement in two-phase boundary layer of a short plate, 2:57301
Rzhebaeva, N.K., *See* Aleksapol'skii, D.Ya., 2:56684

S

Sabatino, A., Gould Drynamic battery, 2:56894
Sablik, J., Technological analysis of conditions of separation of Polish gas and power coal slurries by flotation, 2:55716
Sabri, Z.A., *See* Joos, D.W., 2:56859
Sabrie, J.L., Method of study for cryogenerators in variable operating conditions. physical environment of the field magnet in operation, 2:57268
Sadakane, K., Output control system in a boiling water atomic power plant, 2:56737
Sadovol, A.A., Calculation of nuclear form factors by the method of hyperspherical functions, 2:57614
Sadovskii, A.P., *See* Bogdanov, B.I., 2:57054
Sadowsky, D., *See* Redinger, I.H. Jr., 2:57078
Sadykov, T.A., *See* Khairiddinov, B., 2:56104
Safaev, A.S., *See* Akilov, Yu.Z., 2:57830
Sah, C.T., *See* Lindholm, F.A., 2:56071
Sahlin, H.L., *See* Gullickson, R.L., 2:57653
Saiga, Y., *See* Kitagawa, M., 2:56676
Saito, A., *See* Kunitake, H., 2:56385
Saito, K., Nuclear fuel element, 2:56719
Saito, S., Fuel assembly in a reactor, 2:56715
Saito, T., Method for the arrangement of activated carbon adsorption tower, 2:56701
Sakagami, M., Fuel assembly in a reactor, 2:56577
Sakaguchi, S., *See* Goto, T., 2:56572
Sakai, T., Process for preparing catalytic materials for purifying exhaust gas and catalytic materials prepared thereby, 2:57083
See Matsumura, M., 2:56556
Sakai, Y., Antimony content in the hot spring waters in Gunma Prefecture, 2:56190
See Yoshikawa, A., 2:56050
Sakamoto, K., *See* Ueda, Y., 2:57262
Sakurai, T., *See* Yamada, Y., 2:56669
Salem, S.L., Parametric safety analyses for reduced energetics in PLBR-sized cores, 2:56824
See Wu, J.S., 2:56790
Salleva, R.B., Basis for the development of a solar energy cadaster, 2:56025
Salmon, R., Engineering evaluations of coal conversion processes. Part I. Hydrocarbonization and Synthoil: information base, process selection, and preliminary evaluation of alternatives, 2:55617 (ORNL/TM—5034)
Evaluation of the Synthoil process. Volume I. Process design and economic evaluation of a 100,000-barrel/stream day facility, 2:55615 (ORNL—5209(Vol.1))
Evaluation of the Synthoil process. Volume III. Unit block flow diagrams for a 100,000 barrel/stream day facility, 2:55616 (ORNL—5211)
Salter, G.C., Silicon solar cells using natural inversion layers found in thermally-oxidized p-silicon, 2:56048
Saltmarsh, M.J., *See* Behrisch, R., 2:57494
Samara, G.A., Some applications of high pressure studies of phase transitions in solids, 2:57175 (SAND—77-0104C)
Samarets, G.N., *See* Antikain, P.A., 2:57132
Samollov, E.M., *See* Dikareva, R.P., 2:56024
Samollova, A.Ya., *See* Dikareva, R.P., 2:56024
Samsa, M.E., *See* Huber, C.C., 2:56746
Samsonov, G.N., *See* Balinov, I.M., 2:55670
Samworth, R.B., Power plant impact on chemical quality of surface and groundwaters, 2:57395
Sanada, M., *See* Yoshinaga, M., 2:55552
Sanathanan, C.K., *See* Thie, J.A., 2:56595
Sanborn, J., *See* Carroll, T.O., 2:56915
Sandford, M.T. II, Los Alamos Scientific Laboratory observatory report, 2:57478
Sandkuehler, H., *See* Hofbauer, K., 2:55806
Sandler, B., *See* Auer, I.P., 2:57567
Sandler, Y.M., *See* Glushko, V.V., 2:55747
Sandquist, G.M., Social and environmental assessment of coal and uranium in the Western United States, 2:55939
See Macbeth, P.J., 2:55940
Sandsmark, N., *See* Aamodt, B., 2:56668
Sandusky, D.W., Small leak shutdown, location, and behavior in LMFBR steam generators, 2:56507 (CONF-760503—P1, pp 226-232)
Sanjurjo, A., *See* Kapur, V.K., 2:56039
Santore, R.R., *See* Lewis, R., 2:55563
Santoro, R.T., *See* Uckan, N.A., 2:57714
Sanuki, H., Nonlinear distortion of propagation cones of lower hybrid wave in an inhomogeneous plasma, 2:57679
Saperstein, L.W., Mining engineering's annual review of coal and industrial minerals. I, 2:55684
Saprykin, G.S., *See* Andryushchenko, A.I., 2:56276
Sapunov, Y.M., *See* Abramov, V.V., 2:57565
Saralkin, A.I., *See* Akopin, V.D., 2:57569
Sarantsev, K.B., *See* Dzhigit, G.A., 2:56338
Sargent, A., Western coal transportation: unit trains or slurry pipelines. Final report, 2:57025 (PB—264916)
Sargent, G.A., *See* Reucroft, P.J., 2:55574
Sargis, D.A., *See* Rundquist, D.E., 2:57307
Sarnoch, H., *See* Herberg, G., 2:56559
Sasajima, H., *See* Aoki, T., 2:55868
Sasayama, T., *See* Nishimiya, T., 2:57081
Sato, M., Apparatus for cooling a fuel replacing cell in a reactor, 2:56576
Large scale sodium-water reaction tests for Monju steam generators, 2:56509 (CONF-760503—P1, pp 242-247)
Sato, S., Boiler of tubular nature, 2:56200
Sato, Y., *See* Naito, K., 2:56571
Sauer, R.H., *See* Rickard, W.H., 2:57387
Saupe, R., Rectifier motor as a drive for axial pumps, 2:56693
Saur, J.M., *See* Abramson, R., 2:56484
Savatteri, C., *See* Kottowski, H.M., 2:56607
Savel'ev, V.A., *See* Popyrin, L.S., 2:55665
Savin, V.I., Problems of improving the methods of design of heat supply systems, 2:57009
Savitskii, E.M., Effects of rapid quenching of superconductors, 2:57096
Savitskii, V.G., *See* Dorozhko, E.V., 2:57159, 2:57160
Savvidi, G.K., *See* Matinyan, S.G., 2:57587
Saxton, H.J., Behavior of flawed pressure vessels, 2:57208
Sayre, E.V., Thermoluminescence, a method for determining the date at which a ceramic object was fired, 2:57200 (BNL—22811)
Scalef, J.F., *See* Joyce, M.E., 2:57047
Scailteur, A., *See* Reynen, J., 2:56383
Scala, R.H., *See* Finch, R.E., 2:55863
Scalano, J.C., *See* Small, R.D., 2:57230
Scarton, H.A., *See* Kim, Y.T., 2:56758
Schaefer, J., *See* Bartuska, V.J., 2:55639
Scheppele, S.E., Characterization of coal-derived liquids and other fossil fuel related materials employing mass spectroscopy. Quarterly report, December 30, 1976—March 29, 1977, 2:55643 (FE—2537-2)
Schiffers, A., *See* Andres, O., 2:56663
Schikarski, W., Aerosols in nuclear engineering, 2:56880
Schilling, J.G., *See* White, W.M., 2:57476
Schirra, M., *See* Tas, H., 2:56520
Schlaich, J., Schmehausen cable net cooling tower, 2:56449
Schlapper, G.A., Role of midi-maxi computer interaction in nuclear medicine, 2:57423
Schlemper, L.I., *See* McGrath, S.V., 2:57809
Schlosberg, R.H., *See* Aczel, T., 2:55635
Schlosser, G., *See* Kuschel, D., 2:56393
Schmidt, D., Europe pushes direct cycle development, 2:56438
Schmidt, G., Calculation of nonstationary gas network using the Ganesi program system, 2:55821
Schmidt, G.L., *See* Davis, S.L., 2:57632
Schmidt, J.A., *See* Davis, S.L., 2:57632
Schmidt, S.C., Empirical model to compute the velocity histories of flyers driven by electrically exploding foils, 2:57249 (LA—6809)
Schmitt, F.J., *See* Ahlf, J., 2:56764
Schmutz, H., *See* Huschka, H., 2:55869
Schneider, A., *See* Greenspan, E., 2:56550
Schneider, H., *See* Borgstedt, H.U., 2:56542
Schneider, K., Transportation of vitrified high-level radioactive waste by rail: fault tree analysis and accidental release, 2:55949
Schneider, W., Neutron exposure for safety limitation for reactor pressure vessel steels, 2:57140 (AED-Conf—76-556-004)
Schock, R.N., *See* Costantino, M.S., 2:57474
Schoeller, D.A., *See* Klein, P.D., 2:57407
Schoening, J., *See* Angelini, A., 2:56732
Scholl, M., *See* Bennington, G., 2:56015
Scholz, H., Preventive fire protection measures in nuclear power plants, 2:56869
Scholz, R., Preparation of liquid fuels by gas atomization, 2:57317

Schopf, J.M., Reinhardt Thiessen coal thin-section slide collection of the U.S. Geological Survey: catalog and notes, 2:55647

Schorr, J.R, Study of heat transfer through refractory lined gasifier vessel walls. Quarterly progress report, December 1976—February 1977, 2:55573 (FE—2210-12)

Schreiber, R.E., Operational experience with Westinghouse cores (up to December 31, 1976), 2:56409 (WCAP—8183(Rev.6))

Schreiner, P., *See* Barish, S.J., 2:57564

Schreinlechner, I.E., *See* Konvicka, H.R., 2:56526

Schretzmann, K., *See* Bober, M., 2:56774

Schriever, R.L., Inertial confinement fusion program, 2:57773

Schrock, S.L., *See* Hoffman, N.J., 2:56498
See Shiels, S.A., 2:56524
See Whitlow, G.A., 2:56494

Schubert, E., *See* Paul, D., 2:57527

Schueler, D.G., Photovoltaic system performance, applications and prospects for economic viability in central utility networks, 2:56078

Schuelkem, H., Neutron radiography at the FR 2 in operation, 2:56763

Schueller, H.J., *See* Hagn, L., 2:56692

Schulten, R., HTR near-breeder concept as a means of saving fissile material, 2:56442
Method for the production of hydrogen by water splitting, 2:56614

Schulz, H., Molecular-chain buildup in the FT synthesis, 2:55772

Schuster, J.E., *See* Moody, B.E., 2:55985

Schwartz, S.A., *See* Nussbaumer, D.A., 2:57430

Schwartz, S.R., *See* Herr, J.J., 2:56169

Schwarz, F., Recovery of flare gases: a technical process for economical use of flare gases, 2:55769

Schwarz, N., *See* Rajakovics, G.E., 2:56244

Schwarzer, C., *See* Badur, A., 2:56804

Schweiger, F., Test or measuring sphere for nuclear reactors with spherical fuel elements, 2:56453

Schwighardt, F.K., Spectral analysis of effluents from coal liquefaction processes, 2:55597 (CONF-760885—, pp 72-85)

Schwuttke, G.H., Damage profiles in silicon and their impact on device reliability. Technical report number 1, October 15, 1976—March 30, 1977, 2:57182 (NP—22108)
Silicon ribbon growth by a capillary action shaping technique. Quarterly technical progress report number 7, 2:56031 (ERDA/JPL/954144—77/1)

Sclater, J.G., *See* Jessop, A.M., 2:56207

Scolnick, M.E., Application of field ionization mass spectrometry to the characterization of coal liquefaction products, 2:55598 (CONF-760885—, pp 125-134)

Scott, C.D., *See* Mrochek, J.E., 2:57201

Scott, G.C., *See* Harris, G.S., 2:56955

Scott, M.R., Computational solution of nonlinear two-point boundary-value problems, 2:57814 (SAND—76-5572)

Scott, R.G., *See* Winans, R.E., 2:55636

Scott, W.E., Support grows for trans-Australia gas pipeline, 2:56974

Seaborg, G.T., *See* Hulet, E.K., 2:57601
See Loveland, W., 2:57604

Sease, J.D., *See* Bradley, R.A., 2:56457
See Lackey, W.J., 2:55872

Secen, J., Calculation of oil and solution and free gas initially in place and their recovery during exploration, 2:55749

Sednev, A.R., *See* Kozlov, F.A., 2:56504

Seepolt, R., *See* Eickelpasch, N., 2:56381

Seidel, M.R., The costs of cold weather and the conservation of residential heating gas. Staff report, 2:57015 (PB—264759)

Seiler, W., Automation of coking plant servicing machines, 2:55551
Modern mine ventilation installations, 2:55704

Seitz, M.G., *See* Rest, J., 2:56372

Seitz, W.L., *See* Schmidt, S.C., 2:57249

Sekioka, M., Total heat discharge from northern Azuma geothermal area, 2:56184
Utilization of geothermal energy other than power generation, 2:56205

Sekiya, T., *See* Yamamura, Y., 2:56644

Sekretar, V.E., *See* Zenkevih, Yu.V., 2:56296

Sekretar, V.P., *See* Mitor, V.V., 2:56316

Sekula, S.T., *See* Kerchner, H.R., 2:57141

Self, S.A., *See* Eustis, R.H., 2:56996

Selle, J.E., Corrosion of iron-base alloys by lithium, 2:57134 (CONF-760503—P2, pp 453-461)

Sellin, I.A., *See* Griffin, P.M., 2:57219

Selvatici, E., Short-range order in disordered Fe—Ni alloys investigated by time-dependent perturbed angular correlation technique, 2:57144

Semenov, B.N., Results of investigation of a new combustion chamber, 2:57021

Semerdzhiev, K.I., *See* Angelov, N., 2:57570, 2:57571

Senis, R., *See* Marena, M., 2:56610

Senn, T.J., Evaluation of the hazard associated with fabricating beryllium copper alloys, 2:57461 (UCRL—52258)

Seraphin, B.O., Chemical vapor deposition of thin semiconductor films for solar energy conversion, 2:56125

Serazetdinov, A.Z., *See* Dorfman, L.A., 2:56327

Sergachev, A.I., *See* Kuz'minov, B.D., 2:57610

Sergeev, A.I., Effect of design parameters of a fuel pump section on the injection process and the diesel engine working process, 2:57064

Sergeev, G.V., *See* Kozlov, F.A., 2:56504

Sergeev, V.A., *See* Nikolaev, V.S., 2:57539

Serpekian, T., Investigation of high-temperature reactor heat exchanger materials, 2:56431

Sessions, C.E., *See* Duke, J.M., 2:56505

Sethna, H.N., Experience in transfer of nuclear technology, 2:56632

Setoyama, E., *See* Yamabe, C., 2:57656

Sevast'yanov, A.P., *See* Shpil'rain, E.E., 2:56998

Seyser, E., Air supplants water at Schmehausen, 2:56448

Sgamma, R.B., *See* Sandquist, G.M., 2:55939

Shabrov, N.N., *See* D'yachenko, N.Kh., 2:57324

Shadrina, N.I., *See* Balezin, S.A., 2:56256

Shaffer, D.H., *See* Bamford, W.H., 2:56677

Shafranosh, I.I., *See* Aleksakhin, I.S., 2:57515

Shahrokhi, F., *See* Leavell, W.H., 2:56814

Shampine, W.J., Indiana stream-temperature characteristics. Water-resources investigations (final), 2:57402 (PB—265346)

Shank, K.E., *See* Oakes, T.W., 2:57381

Shanks, H.R., *See* Weber, M.F., 2:57129

Shantz, R., Calculating heat content from ash percentages, 2:55727

Shapiro, G., *See* Auer, I.P., 2:57567

Shapiro, G.A., Results of natural-size investigations of variable conditions of operation of the low pressure section of a district heating turbine, 2:56304

Shapiro, I.S., *See* Lobov, G.A., 2:57584

Shapovalov, Yu.I., *See* Shnitser, I.N., 2:57319, 2:57325

Sharfman, N., *See* Stein, N.A., 2:57566

Sharkey, A.G. Jr., *See* Schwighardt, F.K., 2:55597

Sharkov, B.Y., *See* Bykovskii, Yw.A., 2:57784

Sharon, A., *See* Bankoff, S.G., 2:56532

Sharp, R.D., Analysis of satellite data on energetic particles of ionospheric origin. Final report, 24 Mar. 1975 - 23 Mar. 1976, 2:57491 (N—77—16485)

Shastin, E.G., Stamping unique blades from titanium alloys, 2:56275

Shatilov, S.P., *See* Arkad'ev, B.A., 2:56318

Shavrin, A.I., *See* Paton, B.E., 2:57097

Shaw, D.M., *See* McVey, J.R., 2:55861

Shaw, R., *See* Stein, S., 2:55634

Shaw, R.A., Performance of the Taber South polymer flood, 2:55763

Shchapov, G.A., *See* Gruzdev, N.I., 2:56379
See Margulova, T.Kh., 2:56682

Shcheglova, L.M., *See* Angelov, N., 2:57570, 2:57571

Shcherbin, V.N., *See* Tokarevskii, V.V., 2:57595

Shcherbina, A.V., *See* Prokopenko, A.G., 2:56303

Shchukin, E.M., *See* Parshin, A.A., 2:56321
See Reznik, V.I., 2:56334

Sheely, W.F., Fuels characterization in LMFBR, 2:56544

Sheen, S.H., Analysis on sodium boiling experiment in FFM bundle 3B, test 4, 2:56817
See Carey, W.M., 2:56816

Sheft, I., *See* Gruen, D.M., 2:57002

Sheindlin, A.E., *See* Kirillin, V.A., 2:56990

Sheinina, A.G., *See* Zakhidov, R.A., 2:56124

Sheinzon, E.M., *See* Tyryshkin, V.G., 2:56313

Sheldahl, R.E., *See* Blackwell, B.F., 2:56222

Shelley, E.G., *See* Sharp, R.D., 2:57491

Shelud'ko, L.P., Optimization of the initial gas temperature of peaking gas turbine power plants, 2:56271

Shemagin, I.A., Determination of the stability boundary of a laminar flow of steam with film boiling, 2:57300

Sher, R., *See* Fiarman, S., 2:56759

Sheremeta, O.O., *See* Borisov, A.V., 2:55807

Sheridan, N.R., Solar energy and energy conservation in Australian buildings, 2:56117

Sherman, R.H., Tritium systems test assembly at Los Alamos Scientific Laboratory, 2:57753

Sherry, R.J., *See* Chiao, T.T., 2:57252

Sherwood, W.H., *See* McWilliams, T.M., 2:57828

Shibata, K., *See* Miyazono, S., 2:56387

Shibato, E., Outline of manufacturing and installation experience of pressure vessel structure for the prototype heavy water moderated, boiling light water cooled reactor FUGEN, 2:56466

Shiels, S.A., Influence of LMFBR fuel pin temperature profiles on corrosion rate, 2:56524 (CONF-760503—P1, pp 386-392)

Shifrin, G.A., System for controlling ion implantation dosage in electronic materials, 2:57184

Shigin, V.A., *See* Gokhberg, B.M., 2:57608

Shih, M., Emmy/Unibus interface design specification. Technical note No. 109, 2:57815 (SU—326-P.39-19)

Shikoh, S., Creep properties of electric resistance welded boiler tubes under internal pressure, 2:57261

Shima, M., *See* Takeuchi, A., 2:56186

Shimizu, S., *See* Tunenari, T., 2:57259

Shimojima, H., *See* Mitsutsuka, N., 2:56514, 2:56515

Shimoshige, T., Fuel assembly, 2:56404

Shimotomai, M., *See* Behrisch, R., 2:57494

Shimsman, S.E., Some ways to improve the efficiency of district heating in the tenth five-year plan period, 2:57007

Shiner, V.J. Jr., Isotope effects and reaction mechanisms, 2:57226

Shinohara, Y., Fuzzy set theoretic approach to systems analysis, 2:56599
Shinpo, K., *See* Hosokawa, T., 2:56717
Shipov, R.A., *See* Nabatova, N.A., 2:56326
Shippee, P., Solar hot water heating system, 2:56115
Shiraishi, T., Device for increasing fluid resistance in a core vessel cooling system, 2:56704
Shirakata, H., *See* Takeuchi, H., 2:57642
Shirazi, M.A., Analysis of buoyant surface jets, 2:57386
Shirokov, A.P., Stability of supports of mine workings under seismic loads, 2:55694
Shirokov, S.V., *See* Margulova, T.Kh., 2:56682
Shishkov, V.I., *See* Usov, S.V., 2:56874
Shkarbul', S.N., Analysis of the three-dimensional boundary layer in centrifugal impellers of turbomachines, 2:56270
Shklovskaya, A.I., *See* Angelov, N., 2:57570, 2:57571
Shleifer, B.M., *See* Reznik, V.I., 2:56334
Shmaenok, L.A., *See* Afrosimov, V.V., 2:57657
Shnee, Ya.I., Investigation of a stage with a small d/sub av$/l/sub blade/ ratio and lowered radial gradient of the degree of reactivity, 2:56305
Shnitser, I.N., Aerodynamic characteristics of swirling burners and burnout of pulverized coal spray with peripheral ignition, 2:57325
Development of the burning process with different layouts of vortex burners, 2:57319
Operation of the furnace chamber of the tpp-312a boiler with single-tier layout of burners with the thermal capacity of 100 mw, 2:57327
Shomaker, J.W., *See* Beaumont, E.C., 2:55659
Shor, V.I., *See* Arkad'ev, B.A., 2:56664
Shore, D.E., *See* McElroy, M.W., 2:57035
Shpak, M.T., *See* Danileiko, M.V., 2:57290
Shpil'rain, E.E., Some results of investigation of pressure pulsations in a condensing injector, 2:56998
Shreve, D., *See* Gozani, T., 2:57191
Shriner, D.S., Rainfall simulation for environmental application, 2:57351 (ORNL—5151)
Shterenshis, I.P., Investigation of magnetic filters for iron removal from feedwater of steam generators at nuclear power plants, 2:56687
Shtokman, I.G., Principal tasks and lines of development in higher educational establishments of studies concerning transportation in coal mines in the tenth five-year plan period, 2:55721
Shubenko-Shubin, L.A., Synthesis of optimal design of variable-section rotor blades, 2:56320
Shukla, P.K., Stability of a finite amplitude ion acoustic wave in plasmas, 2:57681
Shumeiko, V.I., *See* Batmanov, Yu.K., 2:55738
Shuvalov, G.I., *See* Filippov, G.A., 2:56286
Shvedova, T.I., *See* Shnee, Ya.I., 2:56305
Shvets, V.V., *See* Lanskaya, K.A., 2:57123
Sidis, V., Some aspects of the molecular approach to atomic collisions, 2:57533
Sidorenko, V.F., Comparative analysis of measuring instruments with evaluation of errors of determination of principal parameters in model tests of hydraulic turbines, 2:57344
See Bavel'skii, D.M., 2:56314
Sidorov, V.A., *See* Kravtsov, N.V., 2:57293
Sidorov, V.I., *See* Baikov, A.B., 2:57018
Siegel, R.D., Technical support to the state of Connecticut in development of an air quality maintenance plan. Final report, 2:57356 (PB—264362)
Sienicki, J.J., *See* Pizzica, P.A., 2:56825
Sigmund, P.M., Recovery of retrograde condensed liquids by revaporization during dry gas injection, 2:55815
Siksin, V.V., *See* Akopin, V.D., 2:57569
Sil'nov, S.M., *See* Bykovskii, YW.A., 2:57784
Silbert, M.G., Fission cross section of ^{249}Bk between 0.7 and 3.0 MeV, 2:57607
Sillion, B., *See* Nechtschein, J., 2:55774
Silora, W., World coal resources, 2:55662
Silsbee, R.H., *See* Ritter, A.L., 2:57103
Silva, R.J., *See* Hulet, E.K., 2:57601
Silvestrov, V.V., *See* Bordzilovskii, S.A., 2:55979
Simanton, J.R., Precision position control and monitoring via CAMAC, 2:57331
Simmons, D.E., *See* Nemecek, J.J., 2:56157
Simmons, J.A., Reversible oxidation of metal oxides for thermal energy storage, 2:56164
Simon, F.F., Experimental investigation with artificial sunlight of a solar hot-water heater, 2:56113
Simons, D., *See* Hofbauer, K., 2:55806
Simoyu, L.L., *See* Shapiro, G.A., 2:56304
Simpkins, J.E., Coatings application for fusion research, 2:57099
Sims, W.H., Considerations in the development of a high performance per unit cost solar collector, 2:56143
Sinel'nikov, L.M., *See* Shirokov, A.P., 2:55694
Singal, R.K., Pressure containing welds in nuclear power systems : meeting the special requirements, 2:56685
Singer, M.N., *See* Stein, N.A., 2:57566
Singer, R., *See* Barish, S.J., 2:57564
Singer, Z., *See* Bencic, B., 2:55770
Singh, D.P., *See* Verma, B.S., 2:55701
Singh, K.N., *See* Chu, T.L., 2:56057
Singh, R.N., *See* Wang, W.L., 2:56709
Singleton, M.F., Assessment of uranium and cerium as hydriding materials for hydrogen isotopes in flowing argon, 2:57799
Sinkevich, O.A., *See* Zubtsov, V.M., 2:57672
Sirl, W.E., Study of nuclear material accounting. Final report, July 1, 1976—April 1, 1977, 2:55956 (NUREG—0290(Vol.1))
Study of nuclear material accounting. Final report, July 1, 1976—April 1, 1977, 2:55957 (NUREG—0290(Vol.2))
Study of nuclear material accounting. Final report, July 1, 1976—April 1, 1977, 2:55958 (NUREG—0290(Vol.3))
Sirota, A.N.N., Influence of temperature on the accumulation and properties of radiation damage in gallium arsenide under electron irradiation, 2:57188
Sisler, J.A., Transportation R and D in ERDA's Division of Environmental Control Technology, 2:55888
Siu, S.K., Continuous spilling of hot oil on ice, 2:55793
Sivaev, V.M., *See* D'yakonov, R.I., 2:56300
Sivtsov, A.I., *See* Parshin, A.A., 2:56321
Sjostrand, N.G., Discrete neutron decay constants above the Corngold limit for infinite slabs, 2:56645
Skaggs, W.D., Water injection device for internal combustion engines, 2:57079
Skinrood, A.C., *See* Murphy, L.M., 2:56087
Skomorovskii, A.Z., *See* Kosyak, Yu.F., 2:56252
Skorduli, V.D., *See* Glushko, V.V., 2:55747
Skowron, L.K., Extracting coal standing on pillars by modified longwall method, 2:55700
Skryl', V.M., *See* Parshin, A.A., 2:56321
See Reznik, V.I., 2:56334
Skudnova, E.V., *See* Belokurova, I.N., 2:57152
Skvortsov, A.A., Main lines of improvement of construction of district heating systems, 2:57011
Slansky, C.M., Alternative fuel cycle technology progress report for April 1—June 30, 1977, 2:55900 (ICP—1122)
Slater, W.L., Production of clean synthesis or fuel gas, 2:55988
Production of clean synthesis or fuel gas, 2:55989
Production of clean synthesis or fuel gas, 2:55990
Slaughter, M.D., Intermultiplet mixing of the vector mesons in a nonperturbative approach to broken SU(4), 2:57586
Slavin, G.B., *See* Popyrin, L.S., 2:55665
Slor, H., Anti ultraviolet-irradiated DNA antibodies in xeroderma pigmentosum patients, 2:57433
Slowinski, B., Emission of protons in π^+ +Xe interactions at 2.34 GeV/c and Fermi motion of neutrons inside the nucleus, 2:57598
Smalls, V.I., Relation between effective diesel engine efficiency and its output of nitrogen oxides with spent gases, 2:57059
Small, M.M., Data report: Marsh/Pond system, 2:57390 (BNL—50600)
Small, R.D., Reaction of Type II biradicals with paraquat ions. Measurement of biradical lifetimes, 2:57230
Smetana, K.M., *See* Hanson, T.J., 2:57199
Smirenkin, G.N., *See* Ignatyuk, A.V., 2:57600
Smirnov, A.N., *See* Donichkin, A.G., 2:57609
Smirnov, A.P., Fluctuational character of phase transition development in liquid helium, 2:57561
Smirnov, B.M., Ionization of highly excited atoms by atomic particle impact, 2:57549
Smirnov, E.V., *See* Akopin, V.D., 2:57569
Smirnov, I.A., *See* Luguev, S.M., 2:57180
Smirnov, V.I., State of the art and trends in the development of foreign turbine construction for nuclear power plants, 2:56696
Smith, A., Comments on the energy-averaged total neutron cross sections of structural materials in the few MeV range, 2:57591 (ANL/NDM—33)
Smith, A.M., *See* Penland, J.R., 2:56771
Smith, C.R.F., *See* Holmes, J.T., 2:56479
Smith, C.W., Stress intensities in flawed pressure vessels, 2:57256
Smith, D.A., *See* Nussbaumer, D.A., 2:57430
Smith, D.E., Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant. Phase II. Quarterly technical progress report, April—June 1977, 2:55568 (FE—1521-51)
Smith, D.L., *See* Stacey, W.M. Jr., 2:57800
Smith, D.R., Steam generating heavy water reactor: design and operational experience, 2:56463
Smith, E.T., *See* Marcus, P.A., 2:55757
Smith, G.C., *See* Allemann, R.T., 2:56345
See Zaloudek, F.R., 2:56236
Smith, G.J., *See* Behrisch, R., 2:57494
Smith, H.V. Jr., *See* Weber, W.J., 2:57150
Smith, J.M., *See* Marrero, T.R., 2:56377
See Pian, C.C.P., 2:56997
Smith, J.N. Jr., Laboratory sputtering studies in fusion research, 2:57723
Smith, P.I.S., Recycling waste, 2:56925
Smith, P.R., Solar water heating in dwellings. survey of selected prospective users in sydney, 2:56112 (PB—264151)
See Onega, R.J., 2:56620

Smith, R.C., Spatial dependence of delayed-neutron signals from uranium exploration probes, 2:55857
Smith, R.J. II, Software engineering techniques in design automation: a tutorial, 2:57827 (UCRL—79426)
Smith, R.K. *See* Betz, W., 2:57557
Smith, R.S., *See* Chung, P.M., 2:55722
Smith, T.S., Fluid flow control valve for gas turbine engine fuel control system, 2:57076
Smith, W.R., *See* Klepper, O.H., 2:56608
Snoeckx, C., Bo'bo' motor-coaches for the Ferrocarriles Guadarrama in Spain, 2:57028
Snyder, J., *See* Auer, I.P., 2:57567
Sobolev, N.N., *See* Volchenok, V.I., 2:57295
Sobolev, Yu.V., *See* Balandin, Yu.F., 2:56694
See Paton, B.E., 2:57097
Sobolevskii, V.S., *See* Azaev, G.A., 2:55995
Sod, G.A., Survey of numerical methods for compressible fluids, 2:57560 (COO—3077-145)
Soenen, M., *See* Lievens, F., 2:56490
Soeoet, O., Dry spent fuel cask handling system, 2:56655
Sohns, D., Reducing power consumption in olefin plants, 2:57040
Sokolov, E.Ya., Scientific and technical problems of district heating in the tenth five-year plan period, 2:57006
Sokolova, V.Yu., *See* Savin, V.I., 2:57009
Solomin, A.N., *See* Angelov, N., 2:57570, 2:57571
Solomon, K.A., Risks from the storage of hazardous chemicals, 2:57458 (PB—265115)
Solov'ev, L.F., *See* Akopin, V.D., 2:57569
Solov'ev, L.K., *See* Shnitser, I.N., 2:57327
Solov'ev, M.I., *See* Angelov, N., 2:57570, 2:57571
Solov'ev, V.F., *See* Volkonskii, N.Y., 2:57574
Solov'ev, V.V., *See* Lobov, G.A., 2:57584
Solov'yanov, V.L., *See* Akopin, V.D., 2:57569
Somov, S.V., *See* Abramov, V.V., 2:57565
Somov, V.V., *See* Musaelyan, A.G., 2:56323
Sonawane, B.R., *See* Andrews, L.S., 2:57415
Sonin, A.A., *See* Corradini, M., 2:56846
Sore, J.C., World coal resources and the role of coal in energy savings at the end of the century, 2:56967
Soudet, P., International coal trade, 2:56968
Southworth, F.H., D-^{3}He-fueled tokamak power reactors, 2:57752
Spaas, H.A.C.M., High pressure vessel flange behavior under transient thermal loadings, 2:56384
Spaelti, E., Aluminum as construction material for cooling towers, 2:56456
Spalaris, C.N., Materials engineering issues, LMFBR steam generators, 2:56503 (CONF-760503—P1, pp 193-201)
Spatschek, K.H., Nonlinear propagation of ion-cyclotron modes, 2:57666
Speck, D.R., *See* Glaze, J.A., 2:57286
Spedding, F.H., Standard state entropies of the aqueous rare earth ions, 2:57214
Spence, D., Classification of Feshbach resonances in electron-molecule scattering, 2:57530
Spencer, B.W., *See* Carey, W.M., 2:56816
Spiegelman, R.D., *See* Anderson, R.C., 2:56929
Spier, E.M., Westinghouse high-density spent fuel rack design, 2:56411
Spies, G.O., Elements of magnetohydrodynamic stability theory, 2:57660 (COO—3077-137)
Spindel, W., Isotope separation processes, 2:57227
Spindler, E., *See* Betz, H.D., 2:57543
Spinrad, B.I., *See* Hornyik, K., 2:56626
Spitznagel, J.A., Primary recoil energy spectra considerations in ion-bombardment experiments, 2:57149
See Choyke, W.J., 2:57148
Spitznagel, J.K., Mechanisms of innate immunity: cytoplasmic granules of polymorphonuclear neutrophilic granulocytes, antimicrobial action, translocation, role, and fate in antimicrobial phagocytosis. Progress report, March 1976—June 30, 1977, 2:57413 (ORO—3628-11)
Spogen, L.R., *See* Adams, R.W., 2:55966, 2:57384
Sprague, J.W., Manganese containing fuels, 2:57087
Springer, T., *See* Bauerle, G., 2:56163
Spruch, L., Variational principles, subsidiary extremum principles, and variational bounds, 2:57548
Sredniawa, V., *See* Slowinski, B., 2:57598
Srinivas, S., Dynamic response of the EBR-II secondary sodium system to postulated leaks of steam and water into sodium, 2:56501 (CONF-760503—P1, pp 188-189)
Sryvtseva, B.P., *See* Bochkarev, G.R., 2:55653
St. John, G.A., *See* Scolnick, M.E., 2:55598
Stacey, W.M. Jr., Modeling and analysis of impurity control techniques for tokamak fusion reactors, 2:57800
Stahlknecht, R., *See* Eibl, K., 2:55822
Stair, P.C., Surface crystallography of clean platinum single crystals and adsorbed hydrocarbon overlayers studied by low energy electron diffraction, 2:57211 (LBL—6221)
Stam, E., Cooperative nuclear engineering-utility programs at North Carolina State University, 2:56625
Stamatelatos, M.G., Accurate approximations to average beta-particle energies and spectra, 2:57618
Stamatovic, A., *See* Hertel, I.V., 2:57525
Stamm, H.H., Sorption of radionuclides on sodium sampling vessels, 2:56754 (CONF-760503—P1, pp 271-277)
Standage, M.D., *See* Kleinpoppen, H., 2:57546
Stanley, P., *See* Fessler, H., 2:56282
Staritskii, V.G., *See* Busyrev, A.I., 2:56005
Staron, T., Determination of the probability of loosening the undermined coal seams in the light of the underground observations and theoretical consideration, 2:55695
Starosel'tsev, V.S., *See* Kontorovich, A.E., 2:55741
Stasyuk, N.P., *See* Prokopenko, A.G., 2:56303
Stauffer, T.R., To breed or not to breed, 2:56553
Steckel, L.M., *See* Jackson, R.L., 2:57242
Steele, R., *See* Jackim, E., 2:57447
Steele, V.E., Organ culture-cell culture system for studying multistage carcinogenesis in respiratory epithelium, 2:57453 (CONF-770342—2)
Steele, W.G., Equation-of-state and nonequilibrium bubble behavior during fast transients, 2:56799
Steffan, W., Feed pump drives - a cost comparison between steam turbine and electric-driven propulsion, 2:56683
Stehling, W., *See* Betz, H.D., 2:57543
Steidl, D.V., *See* Fischer, A.K., 2:57497
Stein, H.J., *See* Mokler, P.H., 2:57542
Stein, M., *See* Seiler, W., 2:55551
Stein, N.A., Comparison of the line-reversed channels p-barp $\pi^-\pi^+$ and π^+p $p\pi^+$ at 6 GeV/c, 2:57566
Stein, S., Thermochemistry and kinetics of coal conversion, 2:55634 (CONF-760885—, pp 135-143)
Steinberg, H.A., Analysis of LWR post-LOCA gamma ray energy redistribution, 2:56806
Steinberg, M., Linear accelerator fission product transmuter (LAFPT), 2:55906
Substituting polyketones and polysulfones for polyethylene, 2:57171
Synthetic carbonaceous fuels and feedstocks from oxides of carbon and nuclear power, 2:55981 (BNL—22785)
See Yang, R.T., 2:55804
Steiner, D., Nuclear fusion: focus on tokamak, 2:57692
Steiner, H., *See* Auer, I.P., 2:57567
Steinkusch, W., Carburization of centrifugally cast tubes in the petrochemical industry and explanation of this behavior based on laboratory tests on Cr—Ni steels and alloys at 800 and 1150°C, 2:57135
Stejskal, E.O., *See* Bartuska, V.J., 2:55639
Stel'makh, V.F., *See* Zhukovskii, P.V., 2:57186
Stenberg, V.I., *See* Woolsey, N.F., 2:55620
Stepanak, S., *See* Brumovsky, M., 2:56873
Stephanakis, S.J., *See* Young, F.C., 2:57652
Stern, E., Physics/engineering interface on the Tokamak Fusion Test Reactor Project, 2:57698
Stettler, A., *See* Michard, G., 2:56193
Stevens, A.L., In situ oil shale fracturing experiment: some preliminary results, 2:55831 (SAND—77-0422C)
Stevens, W.J., Electronic structure of the ground and excited states of Mg^+_2 and Mg_2, 2:57502
Stevenson, A., *See* Crissman, H.A., 2:57416
Stevenson, P.C., *See* Hulet, E.K., 2:57601
Steward, S.A., *See* Alire, R.M., 2:57765
Stewart, J.R., Report of feasibility of high phase order transmission, 2:56355 (CONS/2066—1)
Steyn, J.J., Interface between fuel management and nuclear fuel accounting, 2:56602
Stickler, D.B., *See* Ubhayakar, S.K., 2:55559
Stimart, W.R., Nuclear fuel accounting practice at Duke Power Company, 2:56604
Stinson, T.F., State taxation of mineral deposits and production. Final report, 2:56956 (PB—264575)
Stinton, D.P., *See* Lackey, W.J., 2:55872
Stirsky, P., Complex solution of linear dynamics of WWER-44o nuclear power plant, 2:56426
Stitt, D.H., Safety analysis report on the "Paducah Tiger" protective overpack for 10-ton cylinders of uranium hexafluoride. Supplement 1, 2:57276 (KY—665(Suppl.1))
Stoever, D., *See* Fischer, P.G., 2:56441
Stojanovic, L., *See* Petrovic, K., 2:55777
Stoll, W., *See* Hertel, I.V., 2:57525
Stolyarov, G.M., *See* Pis'man, B.Ya., 2:56681
Stone, C.C., *See* Srinivas, S., 2:56501
Stone, W.J., *See* Beaumont, E.C., 2:55659
Stortenbeek, A.J., Binders of intravenously administered 65-zinc in rat liver cytoplasm, 2:57440 (N—77-16683)
Storti, G., *See* Meakin, J.D., 2:56070
Stout, N.D., *See* Campbell, J.H., 2:55835, 2:55836
Stoyanov, F.A., *See* Shubenko-Shubin, L.A., 2:56320
Strain, J.E., Determination of oxygen in reactive materials by 14-MeV neutron activation analysis, 2:57193
Strain, R.V., Postirradiation examinations of the BG-9 element, 2:56475 (ANL—8067)
Straker, E.A., *See* Fullwood, R.R., 2:55948
Straughan, J., Roadway drivages and drilling in coal mines, 2:55685
Strawbridge, L.E., *See* McCall, T.B., 2:56829

Strehlow, R.A., *See* Omata, I., 2:56803
Strel'tsova, V.I., *See* Bordina, N.M., 2:56053
Strelyuk, M.I., *See* Novash, V.I., 2:56352
Strempel, E., Problems in heating economics and district heating, 2:56914
Stricker, G.D., *See* Meissner, C.R. Jr., 2:55547
Strickler, D., *See* Austin, L.G., 2:55642
Stright, D.H. Jr., *See* Shaw, R.A., 2:55763
Stripinis, P.S., *See* Redinger, I.H. Jr., 2:57078
Strugalski, Z., *See* Slowinski, B., 2:57598
Studier, M.H., *See* Winans, R.E., 2:55636
Stukov, O.I., *See* Kuznetsov, V.M., 2:57572
Styrikovich, M.A., Ways to reduce atmospheric pollution in cities by fuel combustion products, 2:56348
Subbaraman, G., Effect of liquid sodium thermochemical reactions with stainless steels on mechanical response, 2:56518 (CONF-760503—P1, pp 324-330)
Subbotin, B.I., Identification of impurities in sodium and its purification, 2:56488 (CONF-760503—P1, pp 83-93)
Suckewer, S., *See* Davis, S.L., 2:57632
Suenaga, M., *See* Luhman, T., 2:57107
Sugiyama, S., *See* Kihara, H., 2:56680
Sukhov, V.N., *See* Balashov, N.A., 2:56994
Sulyaev, R.M., *See* Abramov, V.V., 2:57565
Sun, Y.H., Simplified method of computing clad and fuel strain and stress during irradiation, 2:56560
See Bari, R.A., 2:56828
Sundberg, E.G., Lead storage battery electrode and method, 2:56901
Sunderman, F.W. Jr., *See* Kasprzak, K.S., 2:57455
Sung, T.Y., DKR: a radioactivity calculation code and decay chain data library, 2:57792
Suntsov, A.N., *See* Lokshin, V.A., 2:56315
Surkov, L.P., Expediency of using monorail suspended railroads with locomotive traction, 2:55709
Susov, A.M., *See* Kravtsov, N.V., 2:57293
Susukida, H., Fracture toughness of welded joints of ASTM A543 steel plate, 2:56674
Sutherland, S., *See* Miley, G.H., 2:57767
Sutotskii, G.P., *See* Zubov, I.V., 2:56291
Sutphin, H.D., *See* Lieber, A.J., 2:57643
Suurkuusk, T.N., *See* Ots, A.A., 2:56306
Suyama, J., Geothermal resources, 2:56176
Suzuki, K., Pressure tube reactor, 2:56471
Suzuki, M., Oxygen concentration distribution in β-phase of the Zry-4 cladding during Zr-steam reaction at LOCA, 2:56781 (JAERI-M—6538)
Suzuki, R., *See* Ishigami, T., 2:56213
Suzuki, T., Method of calculation of detailed power distribution in fuel assemblies, 2:56567
Suzuki, Y., *See* Ninomiya, H., 2:57737
Suzumura, T., Fuel assembly in a reactor, 2:56401
Svetlakova, E.A., *See* Dal'yan, I.B., 2:55751
Sviatoslavsky, I.N., Engineering considerations of the toroidal magnet and dewar for UWMAK. II. A Wisconsin Tokamak fusion reactor design, 2:57718
Svitz, L.N., *See* Novash, V.I., 2:56352
Swain, D.M., Particulate analysis instrumentation for fluidized-bed combustion systems, 2:55726 (FE—2412-T-1)
Swanson, A.R., *See* Nicol, S.K., 2:55652
Swanson, R., Financing and accounting for nuclear fuel: a problem of unknown certainty, 2:56603
Swanson, R.M., Silicon photovoltaic cells in thermophotovoltaic conversion. Progress report, 2:56030 (EPRI-ER—478)
Sweet, D.W., Actinide fission rate measurements in Zebra, 2:56474 (AEEW-R—1090)
Swet, C.J., New directions in heat storage for buildings, 2:56153
Sydykov, Zh.S., *See* Dal'yan, I.B., 2:55751
Syljeset, J.E., *See* Larabi, M., 2:55800
Szczekowski, M., *See* Barish, S.J., 2:57564
Szczepanik, P.A., *See* Klein, P.D., 2:57407
Sze, D.K., Low maintenance, low pressure, low radioactivity graphite blanket concept for fusion reactors, 2:57725
Szostak, L., Safety conditions during testing of oil and gas bearing formations containing hydrogen sulfide, 2:55781
Szyliowicz, J.S., Petropolitics and the Atlantic Alliance, 2:56969 (AD-A—037807)

T

Tagare, S.G., *See* Spatschek, K.H., 2:57666
Takagaki, T., *See* Kamada, K., 2:56900
Takahashi, E., *See* Ueda, Y., 2:57262
Takahashi, H., *See* Omata, I., 2:56803
See Steinberg, M., 2:55906
Takahashi, K., *See* Takeuchi, H., 2:57642
Takayanagi, K., Theory of low energy electron-molecule scattering, 2:57528
Takeda, H., Mixing of particles in a spouted bed, 2:56451
Takeda, S., *See* Sakagami, M., 2:56577
Takeda, T., Improved response matrix method and its verification by one-dimensional analysis on fast reactors, 2:56650
See Kunitake, H., 2:56385
Takejima, M., *See* Saito, T., 2:56701
Takeshita, H., *See* Nishimaki, K., 2:56691
Takeuchi, A., Reproducibility of the distribution of the underground temperature at one meter depth and one verified example of the availability of underground temperature survey, 2:56186
Takeuchi, H., 10-channel neutral particle energy analyser for measurements of ion temperatures on tokamak plasmas, 2:57642
Takeuchi, K., Dynamic analysis of hydraulic pressure wave propagation in a plastically deforming pipe, 2:56840
Takezawa, N., *See* Kobayashi, H., 2:57217
Takishima, T., *See* Sakai, Y., 2:56190
Takizawa, I., *See* Kihara, H., 2:56680
Talbert, D.M., U.S. seabed high-level radioactive waste disposal feasibility study, 2:55928
Talib, A., *See* Konopka, A., 2:56089
Tamai, Y., *See* Kihara, H., 2:56680
Tamm, H., *See* Banerjee, S., 2:55895
Tamura, K., *See* Kitagawa, M., 2:56676
Tanaka, N., *See* Kanazawa, S., 2:57136
Tanaka, Y., Method for urgently cooling a core in high temperature gas reactor, 2:56458
Shielding construction for a reactor, 2:56700
Tang, W.M., Microinstability theory in tokamaks: a review, 2:57664 (PPPL—1354)
Tapucu, A., *See* Boisvert, J., 2:56617
Tarankova, N.D., *See* Landa, P.S., 2:57266
Tas, H., Influence of dynamic sodium on the creep properties of stabilized austenitic steels, 2:56520 (CONF-760503—P1, pp 346-352)
Taube, M., Energy storage in the form of latent heat, 2:56388
Taylor, A., *See* Agarwal, S.C., 2:57151
Taylor, J.C., ELIPTI code: Part I, 2:57826 (UCRL—79328(Pt.1))
Taylor, J.V., *See* Taylor, J.C., 2:57826
Taylor, R.D., *See* Davis, J.W., 2:57314
Taylor, R.G., Criticality safety survey computations of uranium hexafluoride freezer/sublimer tube lattices, 2:57272 (K/DD—1000)
Taylor, R.W., Laboratory experiment demonstrating the way in which a steam barrier prevents the dissolution of salt buried in a flooded packed bed, 2:57212 (UCID—17507)
Silica vaporization and condensation: a potential source of fouling in coal combustion, 2:55650 (UCRL—79146)
Taylor, T.A.H., *See* Allan, C.G., 2:56482
Taylor, V., Is plutonium really necessary, 2:55954 (CONF-7605150—1)
Tazhiev, E.I., *See* Kulichikhin, V.V., 2:56287
Techy, Z., *See* Campolunghi, F., 2:56562
Telkes, M., *See* Birchenall, C.E., 2:56160
Teller, R.G., *See* Koetzle, T.F., 2:57209
Temkin, S.G., *See* Karpin, E.B., 2:56274
Temper, E.M., Characteristics of defect formation in Si subjected to large neutron doses, 2:57185
Teng, L.C., Potential for ion-beam fusion, 2:57777
Tennant, R.W., *See* Li, A.T., 2:57410
Tennery, V.J., *See* Pasto, A.E., 2:56726
Teplyakov, D.I., *See* Aparisi, R.R., 2:56083
ter Area, E., *See* Wann, J.M.R., 2:55680
Terao, K., Explosion limits of hydrogen-oxygen mixture as a stochastic phenomenon, 2:55977
Terchick, A.A., *See* Saperstein, L.W., 2:55684
Terdovidov, A.S., Evaluation of oil and gas potential in Maykopian sedimentary rocks in crimeia, west pre-caucausus and offshore areas of Karkinit Bay and Azov Sea, 2:55754
Terekhova, A.I., Heating bell furnaces with natural gas, 2:57041
Terney, A.N., *See* Matzie, R.A., 2:56601
Teruo, A., Determination of total beryllium in soils by atomic absorption spectrophotometry, 2:57204 (RFP-Trans—225)
Teschendorff, V., Molten fuel-coolant interaction during hypothetical accidents in light water reactors, 2:56876
Tester, J.W., *See* Milora, S.L., 2:56198
Tetel'baum, S.D., Efficacy of the working media of nuclear power plants with gas-cooled fast reactors and low-temperature utilization of heat to obtain fresh water, 2:56563
Mathematical model to analyze the effect of properties of the working media on principal technical and economic indices of nuclear gas turbine plants, 2:56450
Teuchert, E., *See* Schulten, R., 2:56442
Thacher, P.D., Pyranometer calibration: leveling errors and cosine effect, 2:56023 (SAND—77-1047C)
Thein, A., *See* Yamabe, C., 2:57656
Theis, T.L., Contamination of groundwater by heavy metals from the land disposal of fly ash. Technical progress report, September 1, 1976—May 31, 1977, 2:57378 (COO—2727-5)
Therond, J.P., Positive safety electronic control system and process, 2:56740
See Lefebvre, C., 2:56738, 2:56739
Thevenin, M., *See* Abramson, R., 2:56484
Thevenin, Michel, *See* Le Frere, J.P., 2:56579
Thie, J.A., Advanced methodology and systems for power plant pathology, 2:56595
Thoemen, K.H., Incineration of domestic refuse: experience in Germany, 2:56247
Thomas, C.R., Stress-corrosion studies on materials used for surgical implants, 2:57138

Thomas, J., Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-5. Manpower requirements. Final report, January 1975—December 1976, 2:55607 (FE—1752-20)
See Candela, B.J., 2:55606
Thomas, M.T., *See* Behrisch, R., 2:57494
Thomas, R.E., *See* Salter, G.C., 2:56048
Thomas, T.D., *See* Dyer, P., 2:57599
Thomas, V.W. Jr., *See* Nelson, I.C., 2:57436
Thompson, C.J., Characterization of coal syncrudes at BERC, 2:55641 (CONF-760885—, pp 249-253)
See Hirsch, D.E., 2:57206
Thompson, D.A., *See* Behriach, R., 2:57494
Thompson, L.B., *See* Fujishiro, T., 2:56807
Thompson, M.C., Solvent extraction of enriched uranium fuels at the Savannah River Plant, 2:55881 (DP-MS—76-77)
Thomson, J.J., Theoretical interpretation of angle- and polarization-dependent laser light absorption measurements, 2:57772 (UCRL—79628)
Thornton, S.I., *See* Parker, D.G., 2:55648
Tikhomirov, A.N., *See* Usachev, I.P., 2:56325
Tikhomirov, V.A., *See* Reznik, V.A., 2:55719
Tikhonin, F.F., *See* Arbuzov, B.A., 2:57576
Tikhonov, M.F., *See* Koltunov, V.S., 2:55996
Tikhonova, V.V., *See* Antikain, P.A., 2:57132
Tilbrook, R.W., *See* Prasad, K.N., 2:56827
Till, C.E., *See* Chang, Y.I., 2:56546, 2:56600
Till, H.A., *See* Uthe, E.E. Johnson, W.B., 2:57364
Tilmann, W., Brown coal: open pit technique reaches new order of magnitude, 2:55683
Timmings, H.E., *See* Coote, D.R., 2:55826
Tipton, D.L., *See* Koetzle, T.F., 2:57209
Tishchenko, Z.V., Investigation of the high-temperature recuperator of closed-cycle power plants operating on an inert gas, 2:56992
Tishin, A.S., *See* Ignatyuk, A.V., 2:57600
Titov, V.M., *See* Bordzilovskii, S.A., 2:55979
Titushkin, V.A., Low-pressure hydrocracking of a mixture of light fractions of shale and pyrolysis tars, 2:55844
Tkachev, V.D., *See* Zhukovskii, P.V., 2:57186
Tkachuk, A.A., *See* Shnitser, I.N., 2:57327
Tkachuk, N.V., *See* Prokopenko, A.G., 2:56303
Tochio, Y., *See* Sakai, T., 2:57083
Todd, J.H., *See* Weston, L.W., 2:57603
Todreas, N.E., Coolant mixing in LMFBR rod bundles and outlet plenum mixing transients. Progress report, December 1, 1976—February 28, 1977, 2:56531 (COO—2245-38)
See Corradini, M., 2:56846
Toepfer, A.J., Electron-beam technology and electron-beam target experimental results, 2:57776
Togo, Y., *See* Uchikawa, T., 2:56689
Tokar, M., *See* Meyer, R.O., 2:56722
Tokarevskii, V.V., Reactions ^{47}Ti(d,p)^{48}Ti and ^{49}Ti(d,p)^{50}Ti at a deuteron energy 13.6 MeV, 2:57595
Tokarz, R.D., *See* Allemann, R.T., 2:56345
See Zaloudek, F.R., 2:56236
Tola, G., *See* Bernardini, C., 2:56121
Tolchinskii, E.N., *See* Dunskii, V.D., 2:56295
Tomlinson, E.T., Solution of the finite element diffusion and P_1 equations by iteration, 2:56641
Tompkins, L.L., Temperature control system utilizing naturally occurring energy sources, 2:56221
Tonnessen, K.A., Relative hazard of nuclear wastes and naturally occurring toxic minerals, 2:55952
Too, J.J.M., *See* Hsu, T.R., 2:56281
Torrey, M.D., *See* Rivard, W.C., 2:56785
Townes, C.H., *See* Boyd, R.W., 2:57341
Townley, C.H.A., *See* Harrison, R.P., 2:56675
Townsley, W.J., *See* Crossland, B., 2:56679
Towson, D.E., Importance of reservoir description in evaluating in-situ recovery methods for Cold Lake heavy oil. II. In-situ application, 2:55841
Traeger, R.K., Organics used in microelectronics: a review of outgassing materials and effects, 2:57173 (SAND—76-5854C)
Trainham, J.A., Thermodynamic estimation of the minimum concentration attainable in a flow-through porous electrode reactor, 2:57048
Treat, N.L., *See* Whittle, C.E., 2:56741
Trebin, G.F., Classification of hydrocarbon pools, 2:55802
Tregonning, K., Calculation of wastage by small water leaks in sodium heated steam generators, 2:56506 (CONF-760503—P1, pp 218-225)
Tripathi, V.K., Unified formalism of lower hybrid parametric instabilities in plasmas, 2:57668
See Grebogi, C., 2:57686
Trippe, T.G., *See* Herr, J.J., 2:56169
Trofimov, I.F., *See* Paton, B.E., 2:57097
Trofimovskii, V.V., *See* Bavel'skii, D.M., 2:56314
Trollo, M., Design criteria of turbine twisted blading, 2:56283
Troitskii, A.A., *See* Styrikovich, M.A., 2:56348
Trojan, O.A., Industrial internship program in nuclear engineering education, 2:56627
Troshkin, I.A., *See* Zelenskii, K.F., 2:55970
Troyankin, Yu.V., *See* Kochetkov, O.P., 2:57321
Troyanovskii, B.M., Analysis of the influence of the parameters of a turbine stage with a high d/l ratio on stability of its operation, 2:56285
Troyon, F., *See* Chance, M.S., 2:57663
Truesdell, A.H., Procedure for estimating the temperature of a hot-water component in a mixed water by using a plot of dissolved silica versus enthalpy, 2:56209
Trukhnii, A.D., Evaluation of service life of steam turbine casings in thermal fatigue conditions, 2:56302
Trumpler, D.A., *See* Kulwich, M.R., 2:56549
Trushkevich, R.T., *See* Glushko, V.V., 2:55747
Trusov, L.P., Increasing service life of steamlines by repeated heat treatment of pipes, 2:56255
See Zorev, N.N., 2:57121
Ts'ao, H.S., Determination of equivalent response cycles for use in earthquake-induced fatigue analyses, 2:56793 (SAN/1011—106)
Tsai, S.S., Effect of humidity on the burning rate of sodium droplets, 2:56823
Tsang, F.Y., Differential cross section of ^{238}U at 144 keV, 2:57602
Fast-neutron gauging of polyurethane foam, 2:57311
Tsaros, C.L., *See* Arora, J.L., 2:55564
Tschirwitz, U., *See* Meier, H.U., 2:56999
Tseng, W., *See* Meakin, J.D., 2:56070
Tsivtsivadze, E.T., *See* Angelov, N., 2:57570, 2:57571
Tsui, B.M.W., Biokinetics of Tl-201 in mice after intravenous and oral administration of TlCl, 2:57439 (CONF-770673—1)
Tsukerman, V.A., *See* Zelenskii, K.F., 2:55970
Tsushima, Y., *See* Mizuno, N., 2:56398
Tucker, R.W. Jr., *See* Baker, J.P., 2:57315
Tuczek, H., *See* Martin, C., 2:57654
Tunesari, T., Fatigue strength of electron beam welded stainless steel pipes, 2:57259
Tupitsyn, L.V., *See* Paton, B.E., 2:57097
Turekian, K.K., Fate of nuclides in natural water systems. Annual progress report, October 1, 1976—September 30, 1977, 2:57353 (COO—3573-26)
Turner, L.R., Computational model for predicting the characteristics of a superconducting magnet, 2:57734
Turner, R.H., Thermal energy storage using large hollow steel ingots, 2:56161
Turulov, V.A., *See* Akilov, Yu.Z., 2:57830
Tustanovskii, A.S., *See* Kutasov, R.F., 2:56268
Tuvdendorzh, D., *See* Angelov, N., 2:57570, 2:57571
Tyler, L.D., *See* Stevens, A.L., 2:55831
Tyntarev, E.M., Fundamental principles of algorithimization and programming of integrated computer-aided boiler unit design, 2:56322
Tyryshkin, V.G., Rational ways of increasing unit capacity of power gas turbine installations constructed according to a simple thermal diagram, 2:56313

U

Ubbayakar, S.K., Rapid devolatization of pulverized coal in hot combustion gases, 2:55559 (CONF-760885—, pp 254-256)
Uchikawa, T., Application of conversational procedure to optimization of multi-layer radiation shielding design, 2:56689
Ueksn, N.A., ELMO Bumpy Torus Reactor (EBTR) reference design study, 2:57714
See Roberts, J.F., 2:57628
Uebayashi, T., *See* Susukida, H., 2:56674
Ueda, M., Core construction in a pressure tube type heavy water reactor, 2:56472
Ueda, S., *See* Miyazono, S., 2:56387
Ueda, Y., Transient and residual stresses from multipass weld in very thick plates and their reduction from stress relief annealing, 2:57262
Uematsu, K., Core components for a sodium cooling fast breeder, 2:56578
Ugorskii, A.E., Evaluation of concentration of stresses in creep conditions with nonsimple loading, 2:56337
Uher, R.A., Technical feasibility study of railroad electrification with high voltage (10-50 kV) direct current. Final report, Jan—Jun 1976, 2:57065 (PB—265018)
Ujihira, M., Study on the outburst of gas and coal: on the geological structure conditions and back effect of blasting, 2:55690
Ullman, A.Z., Blanket cooling under accident conditions in fusion-fusion hybrid power reactors, 2:57743
See Hecht, M.J., 2:56849
See McKone, T.E., 2:57763
See Okrent, D., 2:57761
Ulrich, W.C., *See* Salmon, R., 2:55615, 2:55616

Ulrikson, G.U., Biohazards of energy production, distribution, use, and conservation: information sources, 2:57460 (CONF-7605159—1)
Umarov, G.Ya., Investigations of a parabolocylindrical solar energy concentrator from mollified glass sheets, 2:56133
Sectional facetal solar energy concentrator, 2:56134
Solar water-raising plant with a diaphragm pump, 2:56095
See Khairiddinov, B., 2:56104
Underhill, D.W., *See* Moeller, D.W., 2:57432
Uphaus, R.A., *See* Katz, J.J., 2:57438
Uporova, V.A., *See* Trusov, L.P., 2:56255
Urakami, K., Heat discharge measurement and geophysical prospecting at Nigorikawa basin, northern part of Komagatake, 2:56183
Usachev, I.P., Calculation and analysis of steady-state regimes of low pressure cylinders of steam turbines, 2:56325
Usenya, M.F., *See* Matveev, V.V., 2:57063
Ushijima, K., *See* Yuhara, K., 2:56185
Usnick, G.B., *See* Lewis, H.E., 2:55625
Usov, S.V., Investigation of self-starting of controlled drives in the system of own requirements of nuclear power plants with fast reactors in conditions of emergency cooling-down, 2:56874
Uthe, E.E. Johnson, W.B., Lidar observations of plume diffusion at Rancho Seco Generating Station, 2:57364
Utrobin, V.P., *See* Imshennik, V.S., 2:57480
Utsunomiya, M., *See* Yoshinaga, M., 2:55552

V

Vaccaro, G., *See* Campolunghi, F., 2:56562
Vagizova, I.P., *See* Parshutina, R.A., 2:56666
Vainer, A.A., *See* Zakhidov, R.A., 2:56123
Vainshtein, S.I., *See* Shpil'rain, E.E., 2:56998
Vakhidov, A.T., Method of theoretical calculation of the area required for a hot box -type heat receiver, 2:56135
Valby, L.E., *See* Berkner, K.H., 2:57798
Vall, A.N., Unified description of the processes $\pi\pi$ $\pi\pi$ and $\pi\pi$ KK-bar, 2:57580
van den Bogaard, J.P.A., *See* Bloemen, H.A., 2:56536
van der Putten, A.P.W.M., *See* Bloemen, H.A., 2:56536
van der Schaaf, B., Fast reactor programme; irradiation effects on the mechanical properties of 18Cr-11Ni stainless steel (DIN 1.4948, type AISI 304 ss). First status report, 2:57142 (ECN—4)
van Heek, K.H., Materials for steam gasification of coal with HTR heat, 2:55593
Van Hook, W.A., Condensed phase isotope effects, especially vapor pressure isotope effects: aqueous solutions, 2:57234
Van Otterloo, R.W., Risk analysis of the road transport of radioactive waste in the Netherlands, 2:55950
Vandenbosch, R., *See* Dyer, P., 2:57599
Vandenhamer, C.J.A., *See* Stortenbeek, A.J., 2:57440
VanderHart, D.L., Analysis of the aromatic content of whole coals by high-power proton decoupled C-13 NMR, 2:55638 (CONF-760885—, pp 202-218)
Vant-Hull, L.L., *See* Kent, T., 2:56148
Vasil'chenko, G.S., Investigation of the structural strength of welded and forged turbogenerator rotors, 2:56330
Vasil'ev, A.A., *See* Ol'khovskii, G.G., 2:56333
Vasil'ev, A.N., *See* Akopin, V.D., 2:57569
Vasil'ev, M.P., Subsidence of packing rocks under pressure, 2:55693
Vaux, W.G., *See* Keeton, A.R., 2:56510
Veatch, F., *See* Sprague, J.W., 2:57087
Vedyaev, V.A., *See* Kiselev, G.P., 2:56253
Vegors, S.H. Jr., *See* Dolan, C.A., 2:55965
Velin, F., *See* Abramson, R., 2:56484
Venkatasetty, H.V., *See* LeFrois, R.T., 2:56158
Venskytis, F.J., *See* Spitznagel, J.A., 2:57149
Vepa, K., *See* McDonald, C.F., 2:56440
Verbinski, V.V., Measurements of coal slurry concentration in haulage pipelines by nuclear techniques, 2:55714
Vercellini, R., *See* Jaffe, F., 2:56174
Verdon, T.A., *See* Schlapper, G.A., 2:57423
Verigin, M.I., *See* Gringauz, K.I., 2:57489
Verity, T.V., Regional mineral developments, 2:56931
Verma, B.S., Point load strength of some Indian rocks, 2:55701
Vernon, S.M., *See* Anderson, W.A., 2:56075
Veshnyakov, E.K., *See* Shnitser, I.N., 2:57327
Vietor, R.H.K., Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-1. Environmental considerations affecting the development of a coal liquefaction industry. Final report, January 1975—December 1976, 2:55605 (FE—1752-16)
Viksman, A.S., Effect of cyclic fuel feeding on the length of the period of delay of fuel self-ignition following diesel engine start in high mountain conditions, 2:57058
Villarreal, R., On-line separation of radioiodine in highly radioactive EBR-II sodium, 2:56512 (CONF-760503—P1, pp 278-279)
Villolobas, A., Efect of porosity on the steady-state swelling of UC, 2:56707
Vinnikov, L.Y., Pinning in niobium and vanadium single crystals containing hydrogen, 2:57162
Vinogradnik, M.V., Method of compiling algorithms and programs for digital computers to optimize load distribution among turbine units of heat-and-power stations, 2:56277
Vinogradov, Yu.A., *See* Balezin, S.A., 2:56256
Vishenskii, V.V., *See* Kochetkov, O.P., 2:57321
Vishnevskaya, K.P., *See* Angelov, N., 2:57570, 2:57571
Vitorovic, D., *See* Petrovic, K., 2:55777
Vnukov, A.K., *See* Styrikovich, M.A., 2:56348
Vogelsang, W.F., *See* Sung, T.Y., 2:57792
Voglewede, J.C., *See* Wrona, B.J., 2:56854
Voight, J.R., Strip-mining and small mammals in southern Iowa, 2:55671 (IS-ICP—44)
Voltov, A.O., *See* Andreev, V.A., 2:57042
Voitovich, A.P., Frequency selection in gas lasers by means of the Faraday effect in the active medium, 2:57288
Volarovich, M. N., Equipment for investigation of physical properties of rocks and minerals at different high pressure intervals, 2:56212
Volchenok, V.I., Mass spectra of the positive ions in the discharge plasma of CO and N_2O lasers, 2:57295
Volk, R.J., *See* Morgan, M.A., 2:57418
Volkonskii, N.Y., Deep-inelastic scattering of leptons by virtual particles, 2:57574
Volpes, R., *See* Culotta, S., 2:57299
Volta, G., *See* Garribba, S., 2:56866
Voltchkov, L.G., *See* Subbotin, B.I., 2:56488
von Baeckmann, W., Cathodic protection of pipes and pipelines offshore, 2:55797
von Rappard, A., Flow in exhaust gas diffusers, 2:56265
von Scholz, H.E., Efficient energy utilization in the European Community: tasks, aims, and tools of the common policy of efficient energy utilization, 2:56945
vonRosenberg, C.W. Jr., *See* Ubhayakar, S.K., 2:55559
Vook, F.L., Ion implantation in metals, 2:57095 (SAND—77-0373)
Voronin, L.M., *See* Rassokhin, N.G., 2:56390
Voronova, T.I., *See* Bogdanov, B.I., 2:57054
Voss, A., *See* Kuschel, D., 2:56393
Voss, M.D., Environmental monitoring at Ames Laboratory: calendar year 1976, 2:56756 (IS—4139)
Vyas, K.C., *See* Ashworth, R.A., 2:57094
Vygen, P., *See* Huschka, H., 2:55869
Vysotskii, M.I., Radiative transitions in the charmonium model, 2:57573

W

Wackerle, J., *See* Schmidt, S.C., 2:57249
Wada, A., Mixing process of pollutants in coastal waters, 2:57392 (NIRS-M—10, pp 1-7)
Waddell, B.V., Reduction of the growth rate of the m = 1 resistive magnetohydrodynamic mode by finite gyroradius effects, 2:57662 (ORNL/TM—5968)
Wagner, E.P. Jr., *See* Dolan, C.A., 2:55965
Wagner, R.E., Energy conservation in dyeing and finishing, 2:56944
Wahba, A.B., *See* Teschendorff, V., 2:56876
Wahl, A.C., Theoretical studies of the atmospheric triatomic molecules H_2O, N_2O, NO_2, CO_2, O_3, and their ions, 2:57501 (ANL—77-3)
Wahlig, M., *See* Berdahl, P., 2:56138
Wakabayashi, H., *See* Oka, Y., 2:56564
Wakamatsu, M., *See* Ito, A., 2:56574
Wakefield, G.F., *See* Rea, S.N., 2:56064
Walker, G., Copper granules in the barnacle Balanus balanoides, 2:57452
Walker, R.B., Quantum versus classical dynamics in the treatment of multiple photon excitation of the anharmonic oscillator, 2:57552
Walker, W., *See* Russell, J.L. Jr., 2:56079, 2:56088
Wall, D.W., *See* Worrell, R.B., 2:57831
Wall, S.M., *See* Appel, B.R., 2:57358
Wallace, A., *See* El-Ghonemy, A.A., 2:57377
Wallace, C.K., Coal mining electrical and electronic engineering, 2:55681
Wallace, T.C., *See* Hollabaugh, C.M., 2:57164
Waller, R.A., Bayesian Zero-Failure (BAZE) reliability demonstration testing procedure for components of nuclear reactor safety systems, 2:56784 (LA—6813-MS)
Walley, K.H., Structural change in feedstocks supply for the petrochemicals industry, 2:55778
Wallington, J.W., Economic benefits of district heating, 2:56910
Wallner, F., *See* Herberg, G., 2:56559
Walser, R.L., *See* Jackson, R.R., 2:55879

Walstrom, P.L., Cryogenic instrumentation needs in the controlled thermonuclear research program, 2:57738
Waltar, A.E., *See* Kennedy, M.F., 2:56821
Walter, R.A., *See* Allemann, R.T., 2:56345
See Zaloudek, F.R., 2:56236
Walther, E.G., Predicted transport of air pollutants from the Navajo and Kaiparowits generating stations into Lake Powell, 2:57359 (PB—265101)
Walton, G.N., *See* Hittle, D.C., 2:56105
Walton, J.R., *See* Lee, E.L., 2:57348
Walton, M., Crustal structure and seismicity in Minnesota, 2:57472
Walton, O.R., *See* Isbell, W.M., 2:57118
Wang, R.T., *See* Nicol, J.A.C., 2:57448
Wang, W.L., Equilibrium index for fission gas bubbles, 2:56709
Wann, J.M.R., Some practical experiences using sulphur hexafluoride as a tracer gas to determine leakage rates in mine ventilation systems, mainly in the South Nottinghamshire area, 2:55680
Wantland, J.L., *See* Han, J.T., 2:56818
Wanzl, W., *See* van Heek, K.H., 2:55593
Warman, J.C., *See* Molz, F.J., 2:56166
Warnke, W.E., Sulfur, moisture and ash reduction in coal preparation research, 2:55554
Warren, G.J., *See* Kruger, P., 2:56196
Warren, H.S., *See* Huff, J.E., 2:57445
Warren, S., Radiation carcinogenesis. Progress report IV, 15 March 1976—15 May 1977, 2:57435 (COO—3017-31)
Warschauer, D.M., Status of the ERDA photovoltaic materials and device studies, 2:56066
Washburn, J., *See* Wu, W., 2:57176, 2:57177
Waters, E.M., *See* Huff, J.E., 2:57445
Watson, J.S., *See* Fisher, P.W., 2:57797
Watson, M., Report on solar thermal power systems and their potential for utility applications, 2:56081
Watts, H.A., *See* Scott, M.R., 2:57814
Watts, J.P., Method and apparatus for strip mining, 2:55674
Watts, J.R., Assessment of potential radiation dose-to-man from an acute tritium release into a forest ecosystem, 2:57382 (DP-MS—76-89)
Watts, J.W. Jr., Charged-particle radiation environment for the Spacelab and other missions in low Earth orbit, revision A, 2:57492 (N—77-16979)
Wawersik, W.R., *See* Gnirk, P.F., 2:55908
Waymire, G.R., Design challenges of serving a maturing LWR industry's spent fuel transportation needs, 2:57279
Waxman, A.R., *See* Chien, S.H., 2:56800
See Villolobas, A., 2:56707
Wear, J.I., Neutron-flux instrumentation for a boiling water reactor, 2:56391
Webb, C.B., *See* Lieber, A.J., 2:57643
Webb, P.R., *See* Gieseke, J.A., 2:56768
Weber, J.W., In-reactor corrosion behavior of stainless steel in high temperature sodium, 2:56523 (CONF-760503—P1, pp 378-385)
Weber, M.F., Surface and electrocatalytic properties of tungsten bronzes, 2:57129 (IS-M—96)
Weber, P., *See* Schlaich, J., 2:56449
Weber, R.E., *See* Qvist, J., 2:57442
Weber, W.H., *See* Lewis, H.E., 2:55625
Weber, W.J., Void formation from 200 to 700°C in heavy-ion irradiated vanadium, 2:57150
Weedman, S.H., *See* Coote, D.R., 2:55826
Weertman, J., Heat extraction from hot, dry rock masses. Progress report 1 Feb-31 Jul 76, 2:56204 (PB—265116)
Wegner, C., *See* Simanton, J.R., 2:57331
Wei, B.C., *See* Young, G.A., 2:56871
Weidman, C., *See* Reiter, M., 2:56177, 2:56182
Weimann, A., *See* Eibl, K., 2:55822
See Schmidt, G., 2:55821
Weinberg, A.M., Can we do without uranium, 2:56936
See Whittle, C.E., 2:56741
Weinberg, I., Effects of outdoor exposure on solar cell modules in the ERDA/NASA Lewis Research Center Ststems Test Facility, 2:56043 (ERDA/NASA/1022—77/13)
Weiner, S.A., Sodium—sulfur battery, 2:56893
Weinstein, P.A., Some public finance aspects of nuclear energy centers. State and local public finance problems and prospects: Some implications of nuclear energy centers, 2:56935 (PB—264611)
Weintraub, D.M., *See* Stein, N.A., 2:57566
Weis, J.H., *See* Baker, M., 2:57583
Weisman, J., *See* Lin, B.I., 2:56371
See MacDonald, P.E., 2:56392
Weiss, W., *See* Rudolph, J., 2:57374
Weitzman, M.L., *See* Cremer, J., 2:56970
Wellesley-Miller, S., *See* Chahroudi, D., 2:56167
Wells, J.E., *See* Cummings, G.E., 2:56863
Welton, L.G., *See* Lipska, A.E., 2:57313
Wemmer, D.E., *See* Pines, A., 2:55640
Wendelken, J.F., Simple goniometer for precise grinding and electropolishing of single crystal surfaces, 2:57343
See Behrisch, R., 2:57494
Wenner, D.B., Geologic feasibility of talc and serpentinite bodies from the Appalachian Mountain region of eastern United States with regard to siting of radioactive-waste repositories. Part I. Additional conclusions relating to ultramafic rocks. Part II. Field investigations of talc and serpentinite deposits. Supplementary report, 2:55918 (Y/OWI/SUB—4496/2)
Wentworth, W.E., Ammonium hydrogen sulfate decomposition for storage of energy for electrical power generation, 2:56152
Weres, O., Nitinol self-descaling surface for geothermal scale control, 2:56201 (LBL—6324)
Werner, S.D., Equivalent viscous damping for seismic analyses of nuclear plants, 2:56792 (SAN/1011—103)
See Ts'ao, H.S., 2:56793
Wescott, R.I., *See* Morris, C.J., 2:56622
Wesolowski, J.J., *See* Appel, B.R., 2:57358
Wessel, W.R., Some subroutines for producing captioned contour line plots and line graphs on film, 2:57805 (ANL-AMD-TM—191)
West, C., *See* Perret, F.L., 2:55953
Westbrook, R.D., *See* Wood, R.F., 2:56029
Weston, L.W., Neutron capture cross section of ^{240}Pu, 2:57603
Weston, R.E. Jr., Isotope effects and quantum-mechanical tunneling, 2:57222
Wewerka, E.M., *See* Loughran, E.D., 2:57345
Whalen, J., *See* Smith, A., 2:57591
Wharton, L., *See* Goodman, N.B., 2:56074
Whatley, A., *See* Byers, L., 2:55784, 2:55786
White, J.R., Effects of RELAP4/MOD5 modeling of the LOFT pressurizer, 2:56761
White, J.S., *See* Hedrick, R.A., 2:56788
White, W.B., *See* Brawer, S.A., 2:57179
White, W.M., Evidence for the Azores mantle plume from strontium isotope geochemistry of the Central North Atlantic, 2:57476
White, W.T., Social aspects of nuclear power plant siting, 2:56747
Whitehurst, D.D., *See* Farcasiu, M., 2:55619
Whitlow, G.A., Corrosion and tribological investigations of chromium carbide coatings for sodium cooled reactor applications, 2:56494 (CONF-760503—P1, pp 138-144)
See Hoffman, N.J., 2:56498
See Johnson, R.N., 2:56492
Whittle, C.E., Economic and environmental implications of a U.S. nuclear moratorium, 1985—2010, 2:56741 (ORAU/IEA—76-4)
Wichner, R.P., Distribution of cesium and other fission products in Peach Bottom HTGR fuel elements, 2:56435
See Dyer, F.F., 2:56436
Widart, J., *See* Reynen, J., 2:56383
Wider, H.U., *See* Pizzica, P.A., 2:56825
Wieckowska, J., *See* Rutkowski, M., 2:55776
Wieczorek, T.W., *See* Fikus, F., 2:57306
Wienke, C.L., *See* Purtymun, W.D., 2:55935
Wierman, R.W., Hydrogen jet recombination under postulated LMFBR accident contitions, 2:56837
Wiggins, P.F., *See* Duffey, D., 2:57192
Wilcox, W.A., *See* Cox, J.L., 2:55555
Wild, E., Friction and wear in liquid-metal systems: comparability problems of test results obtained from different test facilities, 2:56493 (CONF-760503—P1, pp 131-137)
Wild, J.F., *See* Hulet, E.K., 2:57601
Wiles, L.E., *See* Braun, D.J., 2:56241
Wilkes, P., *See* Weber, W.J., 2:57150
Wilkes, W.R., *See* DeWitt, R., 2:56652
Wilkinson, C.D., *See* Marrero, T.R., 2:56377
Wilkinson, W.H., *See* Luce, R.G., 2:56988
Wille, P., Measurement of Nb 93m activity determining the fluence of fast neutrons in power reactors, 2:56665
Williams, B.F., Automated array assembly. Annual report, 2:56037 (ERDA/JPL/954352—77/1)
Williams, I., Installation of the Anderson Strathclyde buttock shearer North Yorkshire area, 2:55682
Williams, J.F., Inelastic electron-hydrogen atom experiments, 2:57523
Williams, L., Present coal and energy policy in the European community, 2:55739
Williams, R., *See* Dau, G., 2:55897
Williamson, K.D. Jr., *See* Haarman, R.A., 2:57742
Williamson, T.G., Density measurements in a burning cigarette, 2:57339
Williford, R.E., Effects of fill-gas composition and eccentric gap geometry on gap conductance of UO_2 fuel rods, 2:56708
Willis, A.R., *See* Saxton, H.J., 2:57208
Wilson, D.A., Recovery of lead from battery scrap, 2:56891
Wilson, D.D., *See* Stewart, J.R., 2:56355
Wilson, E.B., *See* Saperstein, L.W., 2:55684
Wilson, E.M., Tidal energy and system planning, 2:56215
Wilson, G., Oil industry in Scotland, 2:56973
Wilson, J.R., Automatic event tree construction, 2:56865
Wilson, L.T., *See* Magnuson, C.F., 2:57278
Wilson, R.D., *See* Koetzle, T.F., 2:57209
Wilson, R.E., *See* O'Dell, L.D., 2:56778
Wilson, W.J., *See* Blocher, J.M. Jr., 2:56033
Wilson, W.L., *See* Hoffman, N.J., 2:56498
See Johnson, R.N., 2:56492
See Whitlow, G.A., 2:56494
Wilson, W.W., Capital for coal development, 2:55730 (CONF-7511130—1)
Wimpey, F., *See* Siri, W.E., 2:55957
Winans, R.E., Examination and comparison of structure: lignite, bituminous, and anthracite coal, 2:55636 (CONF-760885—, pp 174-188)

Winblad, A.E., *See* Cravens, M.N., 2:55961
Winegardner, W.K., *See* Pelto, P.J., 2:55943
Winegarner, R.M., Heat mirror: a practical alternative to the selective absorber, 2:56150
Wingender, H.J., Risk analysis of radioactive waste management systems in Germany, 2:55944
Winiger, H., Experience with a type 9 gas turbine in iran, 2:56260
Winsen, J., *See* Siri, W.E., 2:55956
Winslow, S.G., *See* Huff, J.E., 2:57445
Winston, R., *See* Goodman, N.B., 2:56074
Winters, K., *See* Nicol, J.A.C., 2:57448
Wirsching, J.E., Matching machines and problems, 2:57823 (UCRL—79287)
Wirtz, J.W., Lead calcium grid casting, 2:56907
Wise, C. E., Free' and renewable energy sources, 2:56170
Witherspoon, J.P., *See* Pechin, W.H., 2:55936
Withrow, S.P., *See* Wendelken, J.F., 2:57343
Witkowski, R.E., *See* Keeton, A.R., 2:56510
Wittenberg, L.J., *See* DeWitt, R., 2:56652
Wittke, D.D., Cooperative education at one utility, 2:56624
Wolf, D.A., *See* Bienert, W.B., 2:56119
Wolf, L., *See* Olmos, J., 2:56867
See Todreas, N.E., 2:56531
Wolfer, W.G., Lifetime considerations for a fusion reactor first wall of type 316 stainless steel, 2:57795
Wolfsberg, M., Corrections to the Born—Oppenheimer approximation in the calculation of iotope effects on equilibrium constants, 2:57223
Wolsko, T.D., *See* Huber, C.C., 2:56746
Wolters, J., *See* Badur, A., 2:56804
Wolverton, B., Don't waste waterweeds, 2:55994
Wolz, G.C., Events following postulated failures in the EBR-II steam generator system, 2:56502 (CONF-760503—P1, pp 189-190)
Wong, A.T., *See* Marcus, P.A., 2:55757
Wong, Y.C., *See* Ruby, L., 2:57592
Wood, D.M., Effective medium theory of optical properties of small particle composites, 2:57169
Wood, G.T., Transmission of solids by pipeline, 2:55715
Wood, J.C., *See* Penn, W.J., 2:56460
Wood, J.R., *See* Harris, G.S., 2:56955
Wood, R.F., Transmutation doping of silicon solar cells, 2:56029 (CONF-770439—1)
Woodall, N.D., Part stability and fixturing techniques for precision machining, 2:57254 (Y/DA—7177)
Woodard, K., Selecting probability for use in direction-dependent accident dispersion models consistent with past NRC practice, 2:56858
See Potter, T., 2:57373
Woodford, J.P., *See* Fletcher, P.B., 2:56941
Woodhall, C.B., Spent fuel storage in the USA, 2:55890
Woolsey, N.F., Approaches to the analysis of solvent refined lignite, 2:55620 (CONF-760885—, pp 234-238)
Worrell, R.B., Barrier Data Base user's guide, 2:57831 (SAND—76-0521)
Wright, D.A., Effect of calcium on cadmium uptake by the shore crab Carcinus maenas, 2:57449
Effect of salinity on cadmium uptake by the tissues of the shore crab Carcinus maenas, 2:57451
Uptake of cadmium into the haemolymph of the shore crab Carcinus maenas: the relationship with copper and other divalent cations, 2:57450
Wright, J.J., *See* Watts, J.W. Jr., 2:57492
Wrona, B.J., Effect of pellet density and axial restraint on failure threshold, 2:56854
Wronski, C.R., *See* Carlson, D.E., 2:56046
Wu, J.S., Decision-table development for use with the CAT code for the automated fault-tree construction, 2:56790 (PB—265098)
Wu, W., Climb of dislocations in boron-ion-implanted silicon, 2:57177
Shrinkage of rod-shaped defects in boron-ion-implanted silicon, 2:57176
Wycklendt, D.A., *See* Hudis, M., 2:56349
Wyckoff, H.L., *See* Stauffer, T.R., 2:56553
Wynne, A., *See* Wann, J.M.R., 2:55680
Wynne, F.E., *See* Cronauer, D.C., 2:55609

Y

Yabe, A., Current methods of internal dose estimation, 2:57429 (NIRS-M—10, pp 70-74)
Yadigaroglu, G., *See* Perret, F.L., 2:55953
Yaffe, S.J., *See* Andrews, L.S., 2:57415
Yagawa, G., Efficient finite element method for nonlinear structural mechanics and its application to transient creep analysis, 2:56690
Yagodovskii, V.D., *See* Denisov, G.N., 2:55997
Yagubov, N.I., *See* Kerimov, Z.G., 2:55766
Yahalom, R., *See* Bein, M., 2:56831
Yakushin, A.N., Determination of optimal characteristics of plate-rib heat exchangers, 2:56257
Yalovoi, N.S., Effect of rotor inlet conditions on the head characteristic of a condensate pump state, 2:56328
Yamaba, R., *See* Kanazawa, S., 2:57136
Yamabe, C., Interaction of TEA CO_2 laser light with laser produced plasma, 2:57656
Yamada, Y., Basic formulation and a computer program for inelastic large deformation analysis, 2:56669
Yamamoto, Y., *See* Takeda, H., 2:56451
Yamamura, Y., Wigner-type continuous slowing down theory for the fast-neutron spectrum, 2:56644
Yamanaka, C., *See* Yamabe, C., 2:57656
Yamashita, I., *See* Nakajo, Y., 2:57263
Yamashita, J., Fuel assembly, 2:56403
Yamazaki, K., *See* Ishii, T., 2:56211
Yandon, K.E., Hanford reservation area worker census: a research report for the Rockwell Hanford Operations, 2:56916 (BNWL—2298)
Yang, R.T., Combustion of carbon. Effect of sulfur dioxide, 2:55804
Yano, S., *See* Takeuchi, H., 2:57642
Yanson, I.K., Josephson effect in tunnel junctions with vanadium and vanadium oxide, 2:57267
Yarnell, P.A., Recovery of uranium sulfate anions on a weak base anion exchange resin, 2:55862
Yaws, C.L., *See* Hansen, K.C., 2:56034
Yee, W., Coal gasification valves. Phase I. Stress analysis report, 2:55576 (FE—2355-13)
Coal gasification valves. Phase I. Design analysis report, 2:55578 (FE—2355-15)
Yeh, H.T., *See* Uckan, N.A., 2:57714
Yeh, J.W., *See* Birss, E.W., 2:57833
Yen, T.F., Chemistry and structure of coal-derived asphaltenes, Phase II. Quarterly progress report, January—March 1977, 2:55610 (FE—2031-7)
Chemistry of asphaltene in coal liquids, 2:55599 (CONF-760885—, pp 144-164)
Yerkes, R.F., Seismicity and faulting attributable to fluid extraction, 2:55794
Yie, G.G., IGT experience in leak detection methodology and systems, 2:55818 (NP—22364)
Yocke, M., *See* Liu, M., 2:57357
Yokosawa, A., *See* Auer, I.P., 2:57567
Yokoyama, M., *See* Yamabe, C., 2:57656
Yokozawa, A., *See* Matsumura, M., 2:56556
Yonco, R.M., Solubility of lithium oxide in liquid lithium, 2:57131
Yoon, J., *See* Hakao, Z., 2:55668
York, T.M., *See* McKenna, K.F., 2:57630
Yoshida, H., Geothermal power plants and their material trends, 2:56202
Yoshida, K., *See* Susukida, H., 2:56674
Yoshida, T., *See* Oda, N., 2:57077
Yoshikawa, A., High efficiency n-CdS/p-InP solar cells prepared by the close-spaced technique, 2:56050
Yoshikawa, K., *See* Oda, N., 2:57077
Yoshimoto, Y., Leakage control device in a main steam isolating valve, 2:56702
Yoshinaga, M., Industrialization of briquette blend coking process, 2:55552
Youdin, M., *See* Reich, T., 2:57420
Young, F.C., Neutron and energetic ion production in exploded polyethylene fibers, 2:57652
Young, G.A., Assessment of soil/structure interaction analysis procedures for nuclear power plant structures, 2:56871
Young, J.A. Jr., Maintenance free batteries: evolution or revolution, 2:56905
Young, J.R., Standard fusion reactor costing methods, 2:57703
Young, R.C., *See* Brugger, R.M., 2:57802
Young, R.T., *See* Wood, R.F., 2:56029
Young, W.C., *See* Svintoslavsky, I.N., 2:57718
Younger, P.R., *See* Kirkpatrick, A.R., 2:56040
Yu, W.S., *See* Lazareth, O., 2:57746
Yudow, B., Alternative energy transmission systems from OTEC plants. Project 8980 third quarter progress report, January 1—March 31, 1977, 2:56091 (DSE/2426—12)
See Konopka, A., 2:56089
Yuhara, K., Ground temperature surveys and thermal discharge measurements at Ibusuki and its surrounding geothermal areas, 2:56185
Yumoto, R., *See* Aoki, T., 2:55868
Yur'ev, L.V., *See* Shnitser, I.N., 2:57319, 2:57325, 2:57327
Yusa, H., *See* Kamiya, K., 2:56402
Yushkevich, V.I., *See* Glushko, V.V., 2:55747

Z

Zagorulko, Yu.I., *See* Subbotin, B.I., 2:56488
Zahn, L.L., *See* Grimm, E.A., 2:56370
Zahner, R.R., *See* Knecht, P.D., 2:56591, 2:56592
Zaitseva, A.K., *See* Bordina, N.M., 2:56053
Zakharko, Yu.A., *See* Pinkhasik, M.S., 2:56993
Zakharov, Yu.V., *See* Shapiro, G.A., 2:56304
Zakhidov, R.A., Aging of silazane protective coating in vacuum, 2:56124
Concentrating capacity of spherical facets, 2:56130
Paraboloid-hyperboloid concentrating systems and their precision, 2:56123
Zakhodov, R.A., Calculation of optical characteristics of radiant energy receivers in high temperature investigations, 2:56131
Zalevskii, V.N., *See* Aleksandrov, A.M., 2:57020

Zalkind, V.I., Investigation of cathode spots in the presence of slag films on open-cycle MHD-generator electrodes, 2:56995
Zaloudek, F.R., Study of the comparative costs of five wet/dry cooling tower concepts, 2:56230 (BNWL—2122)
Zama, M., Conformational states of chromatin, 2:57411 (CONF-770648—1)
Zaplatynsky, I., Oxidation behavior of nickel—chromium—aluminum—yttrium — magnesium oxide and nickel—chromium—aluminum—yttrium — zirconate type of cermets, 2:57163 (N—77—16115)
Zapol, W.M., *See* Qvist, J., 2:57442
Zaporozhchenko, V.A., Ultrashort pulses from a distributed-feedback dye laser, 2:57291
Zaraiskii, S.I., *See* Reznik, V.I., 2:56334
Zare, R.N., The development of visible molecular lasers. Final report, 2:57282 (AD-A—037488)
Zaritskii, S.P., *See* Landa, G.R., 2:56324
Zaryankin, A.E., *See* Kiselev, G.P., 2:56253
Zaugg, P., Brown Boveri air-storage gas turbines, 2:56261
Zeamer, C.J., Recovery from spillage of calcined waste solids, 2:55904
Zeitoun, I.H., Effect of chlorine toxicity on certain blood parameters of adult rainbow trout (Salmo gairdneri), 2:57456
Zeitzschel, G., *See* Kuschel, D., 2:56393
Zel'vyanskii, A.S., Integrated method of determination of optimal reliability indices of the transportation and technological network of a coal mine, 2:55707
Zelenin, N.I., Effect of shale-tar additives on the antiwear properties of motor oils, 2:55850
Zelenskii, K.F., Two-electrode pulsed x-ray tube, 2:55970 (SAND—77-6013)
Zelenskii, V.G., Effect of stress concentrators on the strength of pipes of boiler heating surfaces made of 12cr1mov and Cr18Ni12Ti steel grades, 2:57124
Zeller, M.E., *See* Auer, I.P., 2:57567
Zen, E., Quantitative determination of dawsonite in Green River shale by powder-sample x-ray diffraction: effect of grinding, 2:55848
Zenkevich, Yu.V., *See* Zubov, I.V., 2:56291
Zenkevih, Yu.V., Formation of iron oxide deposits in tubes of supercritical pressure boilers, 2:56296
Zharikov, O.V., *See* Vinnikov, L.Y., 2:57162
Zhiglinskii, A.G., Simultaneous determination of the temperature and density of metal atoms in a plasma, 2:57640
Zhuchko, V.E., Method of obtaining photonuclear cross sections in the near-threshold region, 2:57611
Zhukovskii, G.V., Use of computers for aerodynamic calculations in designing a turbine stage with long blades, 2:56317
Zhukovskii, M.I., Profiling of blades of the working region of the hydraulic turbines in vortex-type flow, 2:56008
Zhukovskii, P.V., Amorphization of silicon by bombardment with oxygen ions of energy below 5 keV, 2:57186
Ziegler, J.F., Profiling hydrogen and helium in materials using ion beams, 2:57338
Zigler, G.L., *See* Mayo, C.W., 2:56363
Zil'berman, B.I., *See* Borovkov, A.I., 2:56335
Zimmer, P.B., *See* Mar, H.Y.B., 2:56126
Zimmerhackl, E., *See* Meier, H.U., 2:56999
Zinger, N.M., Computer-aided hydraulic design of a ramified district heating network, 2:57010
Zinov'ev, A.N., *See* Afrosimov, V.V., 2:57637
Zinterhof, P., *See* Koenne, W., 2:56351
Zisman, M.S., *See* Dyer, P., 2:57599
Zmachinskii, A.V., *See* Lokshin, V.A., 2:56315
Zolotar, B.A., *See* Lin, B.I., 2:56371
Zolotareva, V.A., Problem of formation of salt deposits and their effect on physical processes in flow-through parts of turbines, 2:56298
Zolotukhin, S.T., *See* Nudel', A.M., 2:56686
Zonkhoev, G.B., *See* Usov, S.V., 2:56874
Zorev, N.N., Means for extending the service life of the metal of high-temperature elements of high-capacity power units, 2:57121
Zoutendyk, J.A., Development of low-cost silicon crystal growth techniques for terrestrial photovoltaic solar energy conversion, 2:56062
Zubarev, N.I., Modeling of loads on hydraulic machinery blades, 2:56010
Zubler, R., Typical applications of the gas turbine, 2:56259
Zubov, I.V., Erroneousness of adding hydrogen peroxide into boiler unit tract with brass low-pressure heaters, 2:56297
Operation of an electromagnetic filter in the scheme of a supercritical pressure power unit, 2:56291
Zubtsov, V.M., Development of two- and three-dimensional perturbations in the case of an ionization instability in a channel with nonconducting walls, 2:57672
Zusman, V.M., *See* Antikain, P.A., 2:57132
Zvezdin, Yu.I., *See* Balandin, Yu.F., 2:56694
Zysin, V.A., One-dimensional motion of highly wet steam in nozzles, 2:57305

SUBJECT INDEX

The subject index is based on the use of subject descriptors selected from a controlled thesaurus of terms. Subject descriptors and qualifiers (subheadings) are selected and presented in the following format:

SUBJECT DESCRIPTOR/QUALIFIER
Title, (supplementary information), citation number, (report number)

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processes applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed.

A

A-1 REACTOR (BOHUNICE)
See BOHUNICE A-1 REACTOR

ABSCOPAL RADIATION EFFECTS
Radiation carcinogenesis. Progress report IV, 15 March 1976-15 May 1977 (Abscopal effects of radiation on parabiant rats), 2:57435 (COO-3017-31)

AC SYSTEMS
See also EHV AC SYSTEMS

AC SYSTEMS/FEASIBILITY STUDIES
Report of feasibility of high phase order transmission, 2:56355 (CONS/2066-1)

AC SYSTEMS/SIMULATION
Investigation of hybrid systems for power systems analysis. The ac/hybrid power system simulator. Final report, 2:56356 (EEI-RP-90-2)

AC SYSTEMS/STABILITY
Investigation of hybrid systems for power systems analysis. The ac/hybrid power system simulator. Final report, 2:56356 (EEI-RP-90-2)

ACCIDENTS
See also REACTOR ACCIDENTS
Accidents and unscheduled events associated with non-nuclear energy resources and technology. Final report, 2:56923 (PB-265398)

ACCIDENTS/PROBABILITY
Probabilistic assessment of collisions involving nuclear vessels, 2:56765

ACCOUNTING/MATHEMATICAL MODELS
Estimates and sampling schemes for the instrumentation of accountability systems, 2:55902 (UCRL-13733-1)

ACCUMULATORS/PRESSURE DROP
Bubble growth by expansion and dissolution in a variable pressure field, 2:56813

ACETIC ACID ESTERS/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)

ACETYLENE/CRYSTALLOGRAPHY
Surface crystallography of clean platinum single crystals and adsorbed hydrocarbon overlayers studied by low energy electron diffraction, 2:57211 (LBL-6221)

ACETYLENE/HOT ATOM CHEMISTRY
Gas to liquid to solid transition in halogen hot atom chemistry. IV. The suggestion of multiple enhancement reactions in high energy iodine-128-ethane systems, 2:57240

ACETYLENES
See ALKYNES

ACID ELECTROLYTE FUEL CELLS/CATALYSTS
Investigation of acid-resistant electrocatalysts for fuel cells, 2:56999 (N-77-16444)

ACTINIDES/CHEMICAL BONDS
Electronic configurations and bonding in the early actinide metals, 2:57218

ACTINIDES/ELECTRONIC STRUCTURE
Electronic configurations and bonding in the early actinide metals, 2:57218

ACTINIDES/RADIOACTIVE WASTE DISPOSAL
Fusion-driven actinide burner design study. Final report, 2:57755 (EPRI-ER-451(Vol.1)(5-77))
Fusion-driven actinide burner design study. Final report, 2:57756 (EPRI-ER-451(Vol.2)(5-77))

ACTINIDES/TRANSMUTATION
Report of the workshop on the technological implications of burning actinides to the fuel cycle, 2:55898 (CONF-770354-1)

ACTINOMYCIN/BIOLOGICAL EFFECTS
Nitrate uptake by dark-grown corn seedlings. Some characteristics of apparent induction, 2:57419

ADENOSINE TRIPHOSPHATE
See ATP

ADVANCED GAS COOLED GRAPHITE REACTOR
See AGR TYPE REACTORS

ADVANCED THERMAL REACTOR FUGEN
See JATR REACTOR

AERIAL PROSPECTING/DATA PROCESSING
Gamma-ray measurement and data reduction considerations for airborne radiometric surveys, 2:55859

AEROSOLS
See also RADIOACTIVE AEROSOLS

AEROSOLS/ENVIRONMENTAL TRANSPORT
Atmospheric aerosol research. Annual report, 1975-1976 (Chemical characterization and reaction mechanisms of atmospheric aerosols), 2:57355 (LBL-5214)

AGR TYPE REACTORS/FUEL CHANNELS
Gas-cooled, graphite-moderated nuclear reactor (Patent; AGR), 2:56454

AGR TYPE REACTORS/FUEL CYCLE
Nuclear fuel cycle: (4) the reactors, 2:56606

AGRICULTURE
Biological productivity of renewable resources used as industrial materials, 2:56926 (PB-264457)
Reference materials system: a source for renewable materials assessment, 2:56927 (PB-264494)

AGRICULTURE/LAND RECLAMATION
Land rehabilitation research at Pacific Northwest Laboratories, 2:57387 (BNWL-SA-6089)

AGRICULTURE/SOLAR ENERGY
Solar energy applications in agriculture: potential, research needs, and adoption strategies, 2:56092 (PB-265105)

AIR
See also EARTH ATMOSPHERE

SURFACE AIR
AIR/FLUID FLOW
Calculated and observed nonisothermal multiphase in flow in vertical columns (Mathematical model for movement of air, water vapor, and liquid water in dry desert soil), 2:57375 (ARH-SA-278)
AIR CLEANING SYSTEMS/DESIGN
Centrifugal air precleaner for internal combustion engines (Patent), 2:57049
Containers for radioactive aerosols (Patent; LMFBR), 2:56571
Method for the arrangement of activated carbon adsorption tower (Patent), 2:56701
AIR CONDITIONERS
See also SOLAR AIR CONDITIONERS
Temperature control system utilizing naturally occurring energy sources (Patent), 2:56221
AIR CONDITIONING
See also SOLAR AIR CONDITIONING
AIR CONDITIONING/COMPUTER-AIDED DESIGN
Computer-aided calculation of insolation of rooms, taking into account different shading factors, 2:57830
AIR HEATERS/DESIGN
Intake air heating device for use in internal combustion engine (Patent), 2:57050
AIR POLLUTION/ENVIRONMENTAL TRANSPORT
Operators guide: Atmospheric Release Advisory Capability (ARAC) site facility, 2:57368 (UCID-17490)
AIR POLLUTION/MONITORING
Individual air pollution monitors. 2. Examination of some nonoccupational research and regulatory uses and needs, 2:57352 (BNL-50637)
Predicted transport of air pollutants from the Navajo and Kaiparowits generating stations into Lake Powell, 2:57359 (PB-265101)
The chemistry, dispersion and transport of air pollutants emitted from fossil fuel power plants in California: chemical analysis of particulate samples for sulfate, nitrate, and trace element composition. Final report, Sep-Nov 1974, 2:57358 (PB-264823)
The chemistry, dispersion, and transport of air pollutants emitted from fossil fuel power plants in California: data analysis and emission impact model. Final report, 2:57357 (PB-264822)
AIR POLLUTION/REGULATIONS
Individual air pollution monitors. 2. Examination of some nonoccupational research and regulatory uses and needs, 2:57352 (BNL-50637)
AIR POLLUTION/RESEARCH PROGRAMS
Fiscal year 1976/health and environmental effects research program abstracts, 2:57360 (PB-265381)
AIR POLLUTION/TRANSPORT
Mesoscale air pollution transport in southeast Wisconsin. Final report 1972-1976, 2:57361 (PB-265382)
AIR POLLUTION ABATEMENT/PLANNING
Technical support to the state of Connecticut in development of an air quality maintenance plan. Final report, 2:57356 (PB-264362)
AIRCRAFT/ELECTRIC BATTERIES
Secondary aerospace batteries and battery materials: a bibliography, 1969 - 1974, 2:56888 (N-77-16437)
AIRFOILS/TRANSONIC FLOW
Numerical calculation of the transonic flow past a swept wing, 2:57251 (COO-3077-140)
ALABAMA/COAL DEPOSITS
Data accumulation on selected coal measures in the Warrior Basin of Alabama including search of unpublished reports and surface field mapping. Open file report, 2:55660 (PB-265182)
ALARM DOSEMETERS
See RADIATION MONITORS
ALARM SYSTEMS
Automatic duress alarms through physiological response monitoring, 2:55960 (SAND-77-0191)
ALASKA/OIL FIELDS
Recent new oil sources and their implications for world energy, 2:55760
ALBERTA/NATURAL GAS DEPOSITS
Rock-fluid relationship studies on the Windfall D-3A reservoir and their application in evaluatiang gas cycling effectiveness, 2:55744
ALBERTA/PETROLEUM DEPOSITS
Rock-fluid relationship studies on the Windfall D-3A reservoir and their application in evaluatiang gas cycling effectiveness, 2:55744
ALGORITHMS
Davidon's optimally conditioned algorithms for unconstrained optimization, 2:57807 (ANL-AMD-TM-283(Rev.))
Relationship between the BFGS and conjugate gradient algorithms, 2:57806 (ANL-AMD-TM-282(Rev.))
ALKALI METALS
See also LITHIUM
POTASSIUM
SODIUM
ALKALI METALS/ELECTRON-ATOM COLLISIONS
Electron impact excitation of light atoms (Review, cross sections), 2:57522
ALKALI METALS/ENERGY LEVELS
Hyperfine structure of the highly excited states of alkali atoms, 2:57507
ALKALI METALS/EQUATIONS OF STATE
Equations of state for alkali metals near their critical points, 2:57128 (CONF-770537-4)
ALKANES
See also BUTANE
ETHANE
METHANE
PROPANE
ALKANES/CHEMICAL PREPARATION
Physical and chemical behavior of liquefied coal in solids separation. Quarterly report, January-March 1977 (9 refs), 2:55613 (FE-2550-2)
ALKANES/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
ALKENES
See also ETHYLENE
PROPYLENE
ALKENES/ISOMERIZATION
Contribution to the chemistry of oligo-olefins, 2:55773
ALKENES/PROCESSING
Reducing power consumption in olefin plants, 2:57040
ALKENES/PRODUCTION
Manufacture of hydrocarbons (Patent), 2:55982
Manufacture of hydrocarbons (Patent), 2:55986
ALKENES/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
ALKYNES
See also ACETYLENE
PROPYNE
ALKYNES/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
ALLOYS/MECHANICAL PROPERTIES
Science of materials. Progress report, July 1, 1976-June 30, 1977, 2:57102 (COO-1198-1181)
ALLOYS/PHYSICAL RADIATION EFFECTS
Systematic approach to the radiation damage problem in fission and fusion reactor structural alloys, 2:57143 (UWFDM-184)
ALPHA REACTIONS/FISSION
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
ALRR REACTOR/ENVIRONMENT
Environmental monitoring at Ames Laboratory: calendar year 1976, 2:56756 (IS-4139)
ALRR REACTOR/RADIATION MONITORING
Environmental monitoring at Ames Laboratory: calendar year 1976, 2:56756 (IS-4139)
ALUMINIUM/ABSORPTION SPECTROSCOPY
Determination of aluminum by four analytical methods, 2:57199 (ARH-ST-131)
ALUMINIUM/EVAPORATION
Evaporator (Patent), 2:55866
ALUMINIUM/ION SELECTIVE ELECTRODE ANALYSIS
Determination of aluminum by four analytical methods, 2:57199 (ARH-ST-131)
ALUMINIUM/SHOCK WAVES
High pressure multiple shock response of aluminum, 2:57117 (SAND-77-0027C)
ALUMINIUM/SURFACE COATING
Alcoa 655 selective surface for aluminum, 2:56139
ALUMINIUM/TITRATION
Determination of aluminum by four analytical methods, 2:57199 (ARH-ST-131)
ALUMINIUM/YIELD STRENGTH
High pressure multiple shock response of aluminum, 2:57117 (SAND-77-0027C)
ALUMINIUM 27 TARGET/PROTON REACTIONS
Inelastic interaction of high energy particles with light nuclei and the cluster structure of nuclei (660 MeV; differential cross sections), 2:57593
ALUMINIUM ALLOYS
See also ZIRCALOY
Application of aluminum alloys for solar heating and cooling systems, 2:56144

ALUMINIUM ALLOYS/AGING
Characterization and aging kinetics study of gamma prime strengthened Fe-Cr-Ni experimental alloys for breeder reactors, 2:57119 (WARD-AD-3045-5)
ALUMINIUM ALLOYS/FABRICATION
Studies of design parameters in the fabrication of Nb-Al-Ge superconductors by the powder metallurgy infiltration method, 2:57091 (LBL-5772)
ALUMINIUM ALLOYS/GRAIN GROWTH
Kinetics of formation of the A-15 phase in the Nb-Al-Ge system, 2:57105 (LBL-6266)
ALUMINIUM ALLOYS/LATENT HEAT STORAGE
Thermal storage in metals, 2:56160
ALUMINIUM ALLOYS/MECHANICAL VIBRATIONS
Experimental assessment of the Mindlin-McNiven rod theory, 2:57120
ALUMINIUM ALLOYS/OXIDATION
Oxidation behavior of nickel-chromium-aluminum-yttrium - magnesium oxide and nickel-chromium-aluminum-yttrium - zirconate type of cermets, 2:57163 (N-77-16115)
ALUMINIUM ALLOYS/STRESS CORROSION
Stress-corrosion studies on materials used for surgical implants (T318), 2:57138
ALUMINIUM ALLOYS/SUPERCONDUCTIVITY
Kinetics of formation of the A-15 phase in the Nb-Al-Ge system, 2:57105 (LBL-6266)
Studies of design parameters in the fabrication of Nb-Al-Ge superconductors by the powder metallurgy infiltration method, 2:57091 (LBL-5772)
ALUMINIUM ALLOYS/THERMODYNAMIC PROPERTIES
Thermal storage in metals, 2:56160
ALUMINIUM ALLOYS/WELDABILITY
Ocean transport and storage of liquefied natural gas, 2:55823
ALUMINIUM OXIDES/ABSORPTIVITY
Optical properties of selectively absorbing Ni/Al_2O_3 composite films, 2:57168
ALUMINIUM OXIDES/CHEMICAL PROPERTIES
Chemical and physical stability of refractories for use in coal gasification. First annual progress report, May 1, 1976-April 30, 1977, 2:55565 (COO-2904-4)
Study of chemical behavior of dispersant additives on metal surfaces: reaction of amide functions on aluminum oxide, 2:55774
ALUMINIUM OXIDES/COATINGS
Method and means of reducing erosion of components of plasma devices exposed to helium and hydrogen isotope radiation (Patent), 2:57803
ALUMINIUM OXIDES/CORROSION RESISTANCE
Chemical and physical stability of refractories for use in coal gasification. First annual progress report, May 1, 1976-April 30, 1977, 2:55565 (COO-2904-4)
ALUMINIUM OXIDES/PHYSICAL PROPERTIES
Chemical and physical stability of refractories for use in coal gasification. First annual progress report, May 1, 1976-April 30, 1977, 2:55565 (COO-2904-4)
ALUMINIUM OXIDES/SURFACE PROPERTIES
Study of chemical behavior of dispersant additives on metal surfaces: reaction of amide functions on aluminum oxide, 2:55774
ALUMINIUM OXIDES/WETTABILITY
Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R-1746)
ALUMINIUM SILICATES/CATALYTIC EFFECTS
Manufacture of hydrocarbons (Patent), 2:55982
Manufacture of hydrocarbons (Patent), 2:55986
AMERICIUM 241/FISSION YIELD
Actinide fission rate measurements in Zebra, 2:56474 (AEEW-R-1090)
AMERICIUM 243/FISSION YIELD
Actinide fission rate measurements in Zebra, 2:56474 (AEEW-R-1090)
AMES LABORATORY/ENVIRONMENT
Environmental monitoring at Ames Laboratory: calendar year 1976, 2:56756 (IS-4139)
AMES LABORATORY/RADIATION MONITORING
Environmental monitoring at Ames Laboratory: calendar year 1976, 2:56756 (IS-4139)
AMIDES/CHEMICAL PROPERTIES
Study of chemical behavior of dispersant additives on metal surfaces: reaction of amide functions on aluminum oxide, 2:55774
AMIDES/CHEMISORPTION
Study of chemical behavior of dispersant additives on metal surfaces: reaction of amide functions on aluminum oxide, 2:55774
AMIDES/HYDROLYSIS
Study of chemical behavior of dispersant additives on metal surfaces: reaction of amide functions on aluminum oxide, 2:55774
AMMONIA/ABSORPTION SPECTRA
Ultraviolet part of transient absorption spectrum induced in liquid ammonia by nanosecond pulse radiolysis (23°C), 2:57237
AMMONIA/DECOMPOSITION
Mechanism of the decomposition of ammonia on nickel films at temperatures below and above the Curie point, 2:55997
AMMONIA/PRODUCTION
Small ammonia plants: prospects for natural-gas utilization in developing countries, 2:55810
AMMONIA/RADIOLYSIS
Ultraviolet part of transient absorption spectrum induced in liquid ammonia by nanosecond pulse radiolysis (23°C), 2:57237
ANGRA-2 REACTOR/PLANNING
Angra-2 and -3 nuclear power plants in Brazil, 2:56414
ANGRA-3 REACTOR/PLANNING
Angra-2 and -3 nuclear power plants in Brazil, 2:56414
ANIMAL CELLS/BIOCHEMICAL REACTION KINETICS
Studies on the repair of damaged DNA in bacteriophage, bacterial, and mammalian systems. Three year progress report (UV radiation), 2:57414 (SAN-326P32X15)
ANIMAL CELLS/BIOCHEMISTRY
DNA replication of the parvovirus Kilham rat virus. I. Characterization of intracellular forms of viral DNA extracted by guanidine hydrochloride, 2:57410 (CONF-770555-2)
ANIMAL CELLS/IMMUNITY
Studies in developmental immunogenetics. Annual progress report, 2:57406 (CALT-767P6-X12)
ANIMAL CELLS/MORPHOLOGICAL CHANGES
Organ culture-cell culture system for studying multistage carcinogenesis in respiratory epithelium (Mice), 2:57453 (CONF-770342-2)
ANIMAL SHELTERS/SOLAR SPACE HEATING
Solar energy applications in agriculture: potential, research needs, and adoption strategies, 2:56092 (PB-265105)
ANIONS/AUTOIONIZATION
Collisionally produced autoionizing and autodetaching states of neutral atoms and their negative ions (Review), 2:57510
ANIONS/ENERGY LEVELS
Collisionally produced autoionizing and autodetaching states of neutral atoms and their negative ions (Review), 2:57510
ANIONS/REVIEWS
Negative ions, positive electrons, 2:57555
ANISOLE/CHEMICAL RADIATION EFFECTS
Radiation-induced homolytic aromatic substitution. VI. The effect of metal ions on the hydroxylation of benzonitrile, anisole, and fluorobenzene, 2:57236
ANISOLE/HYDROXYLATION
Radiation-induced homolytic aromatic substitution. VI. The effect of metal ions on the hydroxylation of benzonitrile, anisole, and fluorobenzene, 2:57236
ANTIMONY/ABUNDANCE
Antimony content in the hot spring waters in Gunma Prefecture, 2:56190
ANTIMONY/ION-ATOM COLLISIONS
Study of K, L, and M inner-shell ionization by proton impact (Total cross sections, 150 to 500 Kev, Born approximation), 2:57539
ANTINEUTRINO-NUCLEON INTERACTIONS/CHARGED-CURRENT INTERACTIONS
Scaling-variable distributions for antineutrino-nucleon interactions, 2:57563
ANTINEUTRINO-NUCLEON INTERACTIONS/PARTICLE RAPIDITY
Scaling-variable distributions for antineutrino-nucleon interactions, 2:57563
ANTINEUTRINO-NUCLEON INTERACTIONS/SCALING LAWS
Scaling-variable distributions for antineutrino-nucleon interactions, 2:57563
APARTMENT BUILDINGS/SOLAR AIR CONDITIONING
Initial test results for a solar-cooled townhouse in the mid-Atlantic region, 2:56106
AQUATIC ECOSYSTEMS/BIOLOGICAL MODELS
Impact and fate on aquatic environments of copper from nuclear power plants, 2:57446
AQUATIC ECOSYSTEMS/CHEMICAL ANALYSIS
Adenosine triphosphate concentration in relation to microbial biomass in aquatic systems, 2:57389 (COO-1599-120)
AQUATIC ECOSYSTEMS/MANAGEMENT
Report of a workshop on the impact of thermal power plant cooling systems on aquatic environments, Asilomar, Pacific Grove, California, September 28-October 2, 1975. Volume I. Working group results, 2:57401 (EPRI-SR-38(Vol.1))
AQUATIC ECOSYSTEMS/METABOLISM
Adenosine triphosphate concentration in relation to microbial biomass in aquatic systems, 2:57389 (COO-1599-120)
AQUATIC ECOSYSTEMS/MINERAL CYCLING
Fate of nuclides in natural water systems. Annual progress report, October 1, 1976-September 30, 1977 (Natural ^{234}Th and ^{210}Po

tracer studies of trace metal cycling in coastal waters), 2:57353 (COO-3573-26)
AQUATIC ORGANISMS
(Unspecified biota characteristic of aquatic ecosystems.)
See also CRUSTACEANS
ECHINODERMS
FISHES
MOLLUSCS
AQUATIC ORGANISMS/CONTAMINATION
Vertical distribution of ^{55}Fe in the ocean, 2:57399 (RLO-2231-T1-9)
AQUATIC ORGANISMS/TEMPERATURE EFFECTS
Report of a workshop on the impact of thermal power plant cooling systems on aquatic environments, Asilomar, Pacific Grove, California, September 28-October 2, 1975. Volume I. Working group results, 2:57401 (EPRI-SR-38(Vol.1))
AQUIFERS/SENSIBLE HEAT STORAGE
Experimental study of the subsurface transport of water and heat as related to the storage of solar energy, 2:56166
ARAB REPUBLIC OF EGYPT
See EGYPTIAN ARAB REPUBLIC
ARAGONITE/CRYSTAL GROWTH
Factors influencing crystalline form of calcareous sinters, 2:56213
ARCHAEOLOGICAL SPECIMENS/AGE ESTIMATION
Thermoluminescence, a method for determining the date at which a ceramic object was fired, 2:57200 (BNL-22811)
ARCTIC REGIONS/OIL WELLS
Determination of the front of propagation of the permafrost thawing zone around producing wells, 2:55766
ARCTIC REGIONS/PALEONTOLOGY
Biostratigraphy and taxonomy of devonian megaspores, arctic canada, 2:57466
ARCTIC REGIONS/STRATIGRAPHY
Biostratigraphy and taxonomy of devonian megaspores, arctic canada, 2:57466
ARGENTINA/NUCLEAR INDUSTRY
Nuclear technology experience acquired by Argentina, 2:56636
ARGON/ION-ATOM COLLISIONS
Auger transitions in the quasimolecule $Ar^+ + Ar$ (4 to 7.5 keV; differential cross sections), 2:57516
ARGON 41/MONITORING
Use of sulfur hexafluoride tracer techniques for near-stack dispersion studies, 2:57371
ARGON IONS/AUGER EFFECT
Auger transitions in the quasimolecule $Ar^+ + Ar$ (4 to 7.5 keV; differential cross sections), 2:57516
ARGON IONS/AUTOIONIZATION
Decay of autoionization states in collisions of heavy atomic particles, 2:57509
ARGON IONS/ELECTRON-ION COLLISIONS
(e,2e) reaction, 2:57550
ARGON IONS/ENERGY LEVELS
(e,2e) reaction, 2:57550
Decay of autoionization states in collisions of heavy atomic particles, 2:57509
ARGON IONS/ION-ATOM COLLISIONS
Auger transitions in the quasimolecule $Ar^+ + Ar$ (4 to 7.5 keV; differential cross sections), 2:57516
AROMATICS
See also BENZENE
CONDENSED AROMATICS
TOLUENE
AROMATICS/CHEMICAL PREPARATION
Physical and chemical behavior of liquefied coal in solids separation. Quarterly report, January-March 1977 (9 refs), 2:55613 (FE-2550-2)
AROMATICS/CHEMICAL PROPERTIES
Investigation of aromatic fractions from coal tar produced by an underground coal gasification test, 2:55561 (CONF-770510-7)
AROMATICS/CHEMICAL RADIATION EFFECTS
Radiation-induced homolytic aromatic substitution. VI. The effect of metal ions on the hydroxylation of benzonitrile, anisole, and fluorobenzene, 2:57236
AROMATICS/CHEMICAL REACTION KINETICS
Reaction of Type II biradicals with paraquat ions. Measurement of biradical lifetimes, 2:57230
AROMATICS/CRYSTAL STRUCTURE
Novel co-ordination of sulphur dioxide. The crystal and molecular structure of nitrosyl(sulfur dioxide)bis(triphenylphosphine)rhodium, 2:57233
AROMATICS/HYDROXYLATION
Radiation-induced homolytic aromatic substitution. VI. The effect of metal ions on the hydroxylation of benzonitrile, anisole, and fluorobenzene, 2:57236
AROMATICS/PHYSICAL PROPERTIES
Investigation of aromatic fractions from coal tar produced by an underground coal gasification test, 2:55561 (CONF-770510-7)
AROMATICS/PRODUCTION
Manufacture of hydrocarbons (Patent), 2:55982
Manufacture of hydrocarbons (Patent), 2:55986
AROMATICS/SYNTHESIS
Novel co-ordination of sulphur dioxide. The crystal and molecular structure of nitrosyl(sulfur dioxide)bis(triphenylphosphine)rhodium, 2:57233
ARSENIC 74/ENVIRONMENTAL EFFECTS
Effects of substrate type and arsenic dosage level on arsenic behavior in grassland microcosms. Part I. Preliminary results on ^{74}As transport, 2:57380 (CONF-770647-1)
ARSENIC OXIDES/ADSORPTION
Adsorption of metal ions on colloidal silica, 2:56210
ASHES
See also FLY ASH
ASHES/CATALYTIC EFFECTS
Catalytic activity of coal mineral matter. Interim report, April-September 1976, 2:55626 (FE-2233-2)
Coal catalyst, 2:55629 (AD-D-003508)
ASHES/CHEMICAL COMPOSITION
Characterization of ash from coal-fired power plants. Milestone report May 75-Mar 76, 2:55649 (PB-265374)
Study of the mineral matter distribution in pulverized fuel coals with respect to slag deposit formation in boiler furnaces: Phase 1. Interim report, July-September 1976, 2:55642 (FE-2316-2)
ASPHALTENES
Chemistry of asphaltene in coal liquids (35 refs), 2:55599 (CONF-760885-)
ASPHALTENES/CHROMATOGRAPHY
Chemistry and structure of coal-derived asphaltenes, Phase II. Quarterly progress report, January-March 1977 (15 refs), 2:55610 (FE-2031-7)
ASPHALTENES/SEPARATION PROCESSES
Physical and chemical behavior of liquefied coal in solids separation. Quarterly report, January-March 1977 (9 refs), 2:55613 (FE-2550-2)
ASTROCYTOMAS
See NEOPLASMS
ASTRONOMY/RESEARCH PROGRAMS
Summary of LASL research in astronomy and astrophysics, 2:57478
ASTROPHYSICS/RESEARCH PROGRAMS
Summary of LASL research in astronomy and astrophysics, 2:57478
ATMOSPHERIC PRECIPITATIONS
See also RAIN
ATMOSPHERIC PRECIPITATIONS/CHEMISTRY
Bibliography on precipitation chemistry (subject index), 2:57350 (NP-21685)
ATMOSPHERIC PRECIPITATIONS/SIMULATION
Rainfall simulation for environmental application, 2:57351 (ORNL-5151)
ATOM COLLISIONS
See also ATOM-ATOM COLLISIONS
ATOM-MOLECULE COLLISIONS
ELECTRON-ATOM COLLISIONS
ION-ATOM COLLISIONS
ATOM COLLISIONS/ALIGNMENT
Analysis of inelastic electron-photon coincidence experiments, 2:57546
ATOM COLLISIONS/GLAUBER THEORY
Glauber and Glauber-related methods in atomic physics (Review), 2:57547
ATOM COLLISIONS/MEETINGS
Physics of electronic and atomic collisions, 2:57517
ATOM COLLISIONS/ORIENTATION
Analysis of inelastic electron-photon coincidence experiments, 2:57546
ATOM-ATOM COLLISIONS
Some aspects of the molecular approach to atomic collisions, 2:57533
ATOM-ATOM COLLISIONS/AUTOIONIZATION
Electron ejection in slow heavy particle collisions, 2:57535
ATOM-ATOM COLLISIONS/EXCITATION
Optical emission in slow atomic collisions (Mechanisms optical methods, cross sections, threshold energy, multiplets, total and differential polarization), 2:57534
ATOM-ATOM COLLISIONS/IONIZATION
Decay of autoionization states in collisions of heavy atomic particles, 2:57509
Electron ejection in slow heavy particle collisions, 2:57535
Ionization of highly excited atoms by atomic particle impact (Cross sections,ionization potential), 2:57549
ATOM-MOLECULE COLLISIONS/IONIZATION
Ionization of highly excited atoms by atomic particle impact (Cross sections,ionization potential), 2:57549
ATOMS/AUTOIONIZATION
Collisionally produced autoionizing and autodetaching states of neutral atoms and their negative ions (Review), 2:57510

ATOMS/ENERGY LEVELS
Collisionally produced autoionizing and autodetaching states of neutral atoms and their negative ions (Review), 2:57510
Production and detection of highly excited states, 2:57508
Resonances seen in secondary electron spectra, 2:57559
ATOMS/INFORMATION SYSTEMS
Time for atomic and molecular data bases is now (an overview of data management research at LLL), 2:57832 (UCRL-79286)
ATOMS/P INVARIANCE
Parity violation in atoms due to neutral weak currents, 2:57556
ATOMS/REVIEWS
Atomic physics with synchrotron radiation, 2:57558
ATP
(Adenosine triphosphate.)
ATP/CHEMICAL ANALYSIS
Adenosine triphosphate concentration in relation to microbial biomass in aquatic systems, 2:57389 (COO-1599-120)
ATP/ECOLOGICAL CONCENTRATION
Adenosine triphosphate concentration in relation to microbial biomass in aquatic systems, 2:57389 (COO-1599-120)
AUDITORY ORGANS/MATHEMATICAL MODELS
Lateralization model and the role of time-intensity tradings in binaural masking: Can the data be explained by a time-only hypothesis, 2:57426
AUSTRALIA/NATURAL GAS
Support grows for trans-Australia gas pipeline, 2:56974
AUSTRALIA/SOLAR ENERGY
Solar energy and energy conservation in Australian buildings, 2:56117
AUSTRALIA/SOLAR WATER HEATERS
Solar water heating in dwellings. survey of selected prospective users in sydney, 2:56112 (PB-264151)
AUTOMOBILES/CATALYTIC CONVERTERS
Process for preparing catalytic materials for purifying exhaust gas and catalytic materials prepared thereby (Patent), 2:57083
AUTOMOBILES/EXHAUST GASES
Fuel economy improvement through diagnostic inspection. Technical report, 2:57053 (PB-265064)
Ways to reduce atmospheric pollution in cities by fuel combustion products, 2:56348
AUTOMOBILES/FLYWHEEL ENERGY STORAGE
Flywheels: energy saving way to go, 2:57071
AUTOMOBILES/FUEL CONSUMPTION
Passenger car fuel conservation. Final report, 2:57030 (PB-265369)
AUTOMOBILES/FUEL ECONOMY
Automobile acceleration control for fuel economy (Patent), 2:57082
Fuel economy improvement through diagnostic inspection. Technical report, 2:57053 (PB-265064)
Improving automotive fuel economy with accessory drives. (MS-4171), 2:57074 (CONF-761028-4)
Research safety vehicle program (Phase II) specification review. Volume II. Final technical report, Jul 1975-Nov 1976, 2:57073 (PB-264516)
AUTOMOBILES/FUEL SYSTEMS
Automobile acceleration control for fuel economy (Patent), 2:57082
AUTOMOBILES/LEAD-ACID BATTERIES
Replacement battery. Industry forecast 1975-1979, a report by the BCI Statistical Committee, 2:56892
AUTOMOBILES/MECHANICAL TRANSMISSIONS
Design and development of a continuously variable ratio transmission for an automotive vehicle, 2:57075 (TID-27672)
AUTOMOBILES/SAFETY
Research safety vehicle program (Phase II) specification review. Volume II. Final technical report, Jul 1975-Nov 1976, 2:57073 (PB-264516)
AUTOMOBILES/SPECIFICATIONS
Research safety vehicle program (Phase II) specification review. Volume II. Final technical report, Jul 1975-Nov 1976, 2:57073 (PB-264516)
AUTOMOBILES/STRATIFIED CHARGE ENGINES
Stratified combustion type engine (Patent), 2:57080
AUTOMOTIVE FUELS
See also HYDROGEN FUELS
AUTOMOTIVE FUELS/PRODUCTION
Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels. Quarterly report, December 1976-February 1977, 2:55609 (FE-1800-12)
AUXILIARY WATER SYSTEMS/DESIGN
Water supply system (Patent), 2:56705
Water supply system (Patent; BWR), 2:56405
AZORES ISLANDS/GEOCHEMICAL SURVEYS
Evidence for the Azores mantle plume from strontium isotope geochemistry of the Central North Atlantic, 2:57476

B

BACILLUS SUBTILIS/BIOCHEMICAL REACTION KINETICS
Studies on the repair of damaged DNA in bacteriophage, bacterial, and mammalian systems. Three year progress report (UV radiation), 2:57414 (SAN-326P32X15)
BACTERIA/BIOCHEMICAL REACTION KINETICS
Studies on the repair of damaged DNA in bacteriophage, bacterial, and mammalian systems. Three year progress report (UV radiation), 2:57414 (SAN-326P32X15)
BACTERIOPHAGES/BIOCHEMICAL REACTION KINETICS
Studies on the repair of damaged DNA in bacteriophage, bacterial, and mammalian systems. Three year progress report (UV radiation), 2:57414 (SAN-326P32X15)
BALL BEARINGS/PERFORMANCE TESTING
Experimental investigations of the frictional and wear behavior of tungsten carbide cermet ball bearings under axial load in liquid sodium (LMFBR), 2:56495 (CONF-760503-P1)
BALL BEARINGS/WEAR
Wear of rolling element bearings in sodium (LMFBR), 2:56497 (CONF-760503-P1)
BARIUM/ATOM-MOLECULE COLLISIONS
Crossed molecular beams kinetics: BaO recoil velocity spectra from $Ba + N_2O$, 2:57511
BARYON RESONANCES/MASS SPECTRA
Elastic πN scattering in a dual model with the correct spectrum of baryon resonances, 2:57581
BARYONS
See also BARYON RESONANCES
BARYONS/PAIR PRODUCTION
Effects of neutral currents in the process of $e^+ e^-$ annihilation into a baryon-antibaryon pair, 2:57575
BASALT/CHEMICAL ANALYSIS
Basaltic intrusion and its influence on coal in Seam 507 at Sosnica Colliery (12 refs), 2:55663
BASALT/CHEMICAL COMPOSITION
Evidence for the Azores mantle plume from strontium isotope geochemistry of the Central North Atlantic, 2:57476
BASIC/MANUALS
User's guide to the LLL BASIC interpreter (For 8080-based MCS-80 microcomputer system), 2:57816 (UCID-17090(Rev.1))
BATTELLE PACIFIC NORTHWEST LABORATORIES/ PERSONNEL
Hanford reservation area worker census: a research report for the Rockwell Hanford Operations, 2:56916 (BNWL-2298)
BATTERIES (ELECTRIC)
See ELECTRIC BATTERIES
BATTERY SEPARATORS/MATERIALS
Current trends in battery separators, 2:56904
BEAM INJECTION HEATING
Fueling of toroidal plasmas by ripple-assisted injection of energetic particles, 2:57751
BEAM-PLASMA SYSTEMS/CONVECTIVE INSTABILITIES
Neutral beam driven convective loss cone instability in toroidal geometry, 2:57670
BEAM-PLASMA SYSTEMS/ENERGY LOSSES
Energy loss rates of energetic ions injected into the FM-1 spherator, 2:57632
BEAM-PLASMA SYSTEMS/LOSS CONE INSTABILITY
Neutral beam driven convective loss cone instability in toroidal geometry, 2:57670
BEARINGS
See also BALL BEARINGS
BEARINGS/MECHANICAL VIBRATIONS
Effect of rigidity and damping of bearings on the value of threshold capacity of self-exciting vibrations of steam turbine rotors, 2:56340
BENTHOS/CONTAMINATION
Vertical distribution of ^{55}Fe in the ocean, 2:57399 (RLO-2231-T1-9)
BENZENE/CRYSTALLOGRAPHY
Surface crystallography of clean platinum single crystals and adsorbed hydrocarbon overlayers studied by low energy electron diffraction, 2:57211 (LBL-6221)
BENZENE/STRUCTURAL MODELS
X-ray diffraction pattern and models of liquid benzene, 2:57553
BENZENE/X-RAY DIFFRACTION
X-ray diffraction pattern and models of liquid benzene, 2:57553
BENZOPYRENE/METABOLISM
Characterization and induction of aryl hydrocarbon [benzo(a)pyrene] hydroxylase in rabbit bone marrow, 2:57415
BERKELIUM 249 TARGET/NEUTRON REACTIONS
Fission cross section of ^{249}Bk between 0.7 and 3.0 MeV, 2:57607
BERNSTEIN MODE/FLUTE INSTABILITY
Radiation coupling of Bernstein modes in a ring plasma, 2:57680
BERYLLIUM/ABSORPTION SPECTROSCOPY
Determination of total beryllium in soils by atomic absorption spectrophotometry, 2:57204 (RFP-Trans-225)

BERYLLIUM/DIFFUSION
Determination of total beryllium in soils by atomic absorption spectrophotometry, 2:57204 (RFP-Trans-225)
BERYLLIUM/ELECTRON COLLISIONS
Investigation of plasmon excitation by oblique incidence of a beam of primary electrons of medium energy in reflection experiments (50 to 500 eV, 0 to 88°), 2:57498
BERYLLIUM/GRUENEISEN CONSTANT
Determination of the Grueneisen γ for beryllium at 1.2 to 1.9 times standard density, 2:57113 (LA-UR-77-1292)
BERYLLIUM/SHOCK WAVES
Response of porous beryllium to static and dynamic loading, 2:57118 (UCRL-79712)
BERYLLIUM 9 TARGET/PROTON REACTIONS
Inelastic interaction of high energy particles with light nuclei and the cluster structure of nuclei (660 MeV; differential cross sections), 2:57593
BERYLLIUM BASE ALLOYS/FABRICATION
Evaluation of the hazard associated with fabricating beryllium copper alloys, 2:57461 (UCRL-52258)
BERYLLIUM BASE ALLOYS/HEALTH HAZARDS
Evaluation of the hazard associated with fabricating beryllium copper alloys, 2:57461 (UCRL-52258)
BERYLLIUM MODERATORS
See BERYLLIUM
BERYLLIUM OXIDES/COATINGS
Method and means of reducing erosion of components of plasma devices exposed to helium and hydrogen isotope radiation (Patent), 2:57803
BETA DECAY/ENERGY SPECTRA
Accurate approximations to average beta-particle energies and spectra, 2:57618
BEVERAGES/PRODUCTION
State of the art: wastewater management in the beverage industry, 2:57047 (EPA-600/2-77-048)
BI-GAS PROCESS/CATALYSTS
Gas generator research and development: BI-GAS process. Quarterly report, January-March 1977, 2:55567 (FE-1207-29)
BI-GAS PROCESS/ECONOMICS
Economic comparison of two BIGAS coal gasification processes (Bigas at 1200 psig and modified Bigas at 470 psig), 2:55570 (FE-2024-4)
BI-GAS PROCESS/PILOT PLANTS
Gas generator research and development: BI-GAS process. Quarterly report, January-March 1977, 2:55567 (FE-1207-29)
BI-GAS PROCESS/RESEARCH PROGRAMS
Gas generator research and development: BI-GAS process. Quarterly report, January-March 1977, 2:55567 (FE-1207-29)
BIKINI/RADIATION MONITORING
Dose assessment at Bikini Atoll (^{90}Sr, ^{137}Cs), 2:57437 (UCRL-51879(Pt.5))
BIOLOGICAL RADIATION EFFECTS
See also ABSCOPAL RADIATION EFFECTS
BIOLOGICAL RADIATION EFFECTS/RESPONSE MODIFYING FACTORS
Radiation safety (Criteria for radiation protection standards), 2:57428 (CONF-770615-2)
BIOMASS
(All growing organic matter such as plants, trees, grasses, and algae.)
See also PLANTS
Biological productivity of renewable resources used as industrial materials, 2:56926 (PB-264457)
Reference materials system: a source for renewable materials assessment, 2:56927 (PB-264494)
BIOMASS/SOLAR ENERGY CONVERSION
Don't waste waterweeds (Use of water hyacinths as fertilizer, biogas generator, and animal feed), 2:55994
BISMUTH/COMPATIBILITY
Compatibility of bismuth and bismuth-lithium solutions with refractory metals and graphite, 2:57108 (CONF-760503-P2)
BISMUTH/X-RAY FLUORESCENCE ANALYSIS
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57198 (LA-6869-MS)
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57197 (LA-6869)
BISMUTH 209 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
BISMUTH 209 TARGET/KRYPTON 86 REACTIONS
Angular-momentum transfer in deeply inelastic scattering of 610-MeV ^{86}Kr by ^{209}Bi (Angular correlations of fragments from fissioning heavy reaction products), 2:57599
BISMUTH COMPLEXES/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance studies of diamagnetic metal-aminopolycarboxylate complexes, 2:57229
BITUMINOUS COAL/HEATING
Rapid devolatization of pulverized coal in hot combustion gases (9 refs), 2:55559 (CONF-760885-)
BITUMINOUS COAL/OXIDATION
Oxidations of coal, coal fractions, and coal models (9 refs), 2:55637 (CONF-760885-)
BITUMINOUS COAL/PYROLYSIS
Rapid devolatization of pulverized coal in hot combustion gases (9 refs), 2:55559 (CONF-760885-)
BITUMINOUS COAL/SOLUBILITY
Kinetics and mechanisms of solvent refining coal, 2:55619 (CONF-760885-)
BLACK FOX-1 REACTOR/REACTOR SAFETY
Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I-VI, 2:56787 (ORNL/NUREG/NSIC-136)
BLACK FOX-2 REACTOR/REACTOR SAFETY
Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I-VI, 2:56787 (ORNL/NUREG/NSIC-136)
BLANKETS (BREEDING)
See BREEDING BLANKETS
BLAST FURNACES/GLOBAL ASPECTS
Coke production: metallurgical coke, foundry coke, molded coke, 2:55550
BLAST FURNACES/OPERATION
Effect of coke properties on blast furnace operation (4 refs), 2:55628
BLOOD/OXYGEN
pH and haemoglobin oxygen affinity in blood from the antarctic cod Dissostichus mawsoni, 2:57442
BLOOD/PH VALUE
pH and haemoglobin oxygen affinity in blood from the antarctic cod Dissostichus mawsoni, 2:57442
BLOWDOWN
Tracking nonstationary velocity in two-phase flow by an adaptive cross-correlation algorithm, 2:56814
BLOWERS/EFFICIENCY
Method of improving operating efficiency of blow fans and exhaust fans of the 0.55-40-1 type, 2:57039
BOHUNICE A-1 REACTOR/REACTOR KINETICS
Physics calculations of A-1 type heavy water reactors, 2:56469
BOILER FUEL/COMBUSTION PROPERTIES
Investigation of aerodynamics, ignition and burnout of spray in the furnace of a BKZ-420-140-1 boiler with twinned vortex burners of ekibastuz coal, 2:55729
BOILERS/AEROSOL WASTES
Dustfree removal of electrically filtered flyash experiences with screening, 2:55651
BOILERS/AIR POLLUTION CONTROL
Guidelines for industrial boiler performance improvement. (Boiler adjustment procedures to minimize air pollution and to achieve efficient use of fuel), 2:57035 (PB-264543)
BOILERS/BURNERS
Aerodynamic characteristics of swirling burners and burnout of pulverized coal spray with peripheral ignition, 2:57325
Development of the burning process with different layouts of vortex burners, 2:57319
Operation of the furnace chamber of the tpp-312a boiler with single-tier layout of burners with the thermal capacity of 100 mw, 2:57327
BOILERS/CLEANING
Combined method of cleaning boiler heating surfaces, 2:56306
Improvement of cleaning of boiler heating surfaces by steam blowing devices, 2:56307
BOILERS/COMBUSTION CHAMBERS
Some questions of high-temperature vanadic corrosion and principal lines of development of heat-resistant materials, 2:57137
BOILERS/COMPUTER-AIDED DESIGN
Fundamental principles of algorithimization and programming of integrated computer-aided boiler unit design, 2:56322
BOILERS/CONTROL EQUIPMENT
Improving the reliability of automatic calculation of technical and economic performance indices by the automatic error correction method, 2:56292
BOILERS/CORROSION
Contamination of heating surfaces of boilers at Tyumen heat and power plant burning local peat, 2:56295
Importance of experience in scale removal, 2:56258
BOILERS/CORROSION PROTECTION
Protection of boiler steels from corrosion in solutions of trilon b and organic acids at temperatures of 100-170°C, 2:56256
BOILERS/DEPOSITS
Erroneousness of adding hydrogen peroxide into boiler unit tract with brass low-pressure heaters, 2:56297
Formation of iron oxide deposits in tubes of supercritical pressure boilers, 2:56296
BOILERS/DESIGN
Dynamic characteristics of a boiler with combined circulation of a medium, 2:56294

Gas and fuel oil boiler unit for an 800 mW power block, 2:56321
Investigation of aerodynamics, ignition and burnout of spray in the furnace of a BKZ-420-140-1 boiler with twinned vortex burners of ekibastuz coal, 2:55729
BOILERS/ECONOMIZERS
Industrial tests of a membrane economizer on a TP-120 boiler at the Saratov No.2 heat-and-power plant, 2:56315
BOILERS/FEEDWATER
Erroneousness of adding hydrogen peroxide into boiler unit tract with brass low-pressure heaters, 2:56297
BOILERS/FILTERS
Operation of an electromagnetic filter in the scheme of a supercritical pressure power unit, 2:56291
BOILERS/FLUE GAS
Determination of balance temperatures along the gas tract of the boiler by means of reduced fuel characteristics, 2:57323
Lowering of pollutant content in emissions from fuel combustion in boilers of middle capacity, 2:55791
BOILERS/FOULING
Study of the mineral matter distribution in pulverized fuel coals with respect to slag deposit formation in boiler furnaces: Phase 1. Interim report, July-September 1976, 2:55642 (FE-2316-2)
BOILERS/FUEL CONSUMPTION
Guidelines for industrial boiler performance improvement. (Boiler adjustment procedures to minimize air pollution and to achieve efficient use of fuel), 2:57035 (PB-264543)
BOILERS/MATERIALS
Steel grades for tubes of heating surfaces of high-capacity highly efficient boilers, 2:57132
BOILERS/OPERATION
Investigation of circulation and separation characteristics of a low-capacity high pressure boiler with external cyclone, 2:56323
BOILERS/PERFORMANCE
Dynamic characteristics of a boiler with combined circulation of a medium, 2:56294
Investigation of circulation and separation characteristics of a low-capacity high pressure boiler with external cyclone, 2:56323
BOILERS/PIPES
Effect of stress concentrators on the strength of pipes of boiler heating surfaces made of 12cr1mov and Cr18Ni12Ti steel grades, 2:57124
BOILERS/RELIABILITY
Raising the reliability of boiler units by improving the quality of welding of the heating surfaces, 2:56273
BOILERS/SAFETY STANDARDS
Determination of the permissible deflection of boiler headers at steam power plants, 2:56290
BOILERS/STRESS ANALYSIS
Stress analysis of finned-tube water-walls of boilers (Photoelastic models), 2:56282
BOILERS/SUPERHEATERS
Selection of thermal diagram of intermediate superheaters of gas and oil fuel-fired boilers, 2:56334
BOILERS/SYSTEMS ANALYSIS
Improving the reliability of automatic calculation of technical and economic performance indices by the automatic error correction method, 2:56292
BOILERS/THERMAL EFFICIENCY
Comparative tests of a TP-100 boiler with closed-loop and open-loop systems of p.f. preparation when burning Lvov-Volynian pit coal, 2:56312
Guidelines for industrial boiler performance improvement. (Boiler adjustment procedures to minimize air pollution and to achieve efficient use of fuel), 2:57035 (PB-264543)
BOILERS/TUBES
Creep properties of electric resistance welded boiler tubes under internal pressure, 2:57261
BOILING WATER REACTORS
See BWR TYPE REACTORS
BOLIVIA/GEOLOGY
General study of the region of Lake Titicaca, Bolivia, using a satellite multispectral scanning system. Petrologic study of metamorphic rocks in the Zongo Valley in Bolivia. Installation project of a bacteria in the Los Monos Plains. Geological study of the Ulla Charzani region, 2:57463 (E-76-10453)
BOLTS
See FASTENERS
BOOKKEEPING
See ACCOUNTING
BOR-60 REACTOR/RADIOACTIVITY TRANSPORT
Radioactive product behavior during the operation of sodium-cooled reactors of the USSR, 2:56481 (CONF-760503-P1)
BOREHOLES/OPTIMIZATION
Determination of the optimum depression in methane-drainage boreholes in mines (2 refs), 2:55696
BOREHOLES/TESTING
Safety conditions during testing of oil and gas bearing formations containing hydrogen sulfide, 2:55781
BORIC ACID/ABUNDANCE
Boric acid content of hot springs and river waters at Owakudani Valley, Volcano Hakone, 2:56192
BORIDES/CURIE POINT
Ferromagnetic and antiferromagnetic coupling in amorphous (Ni/sub 100-c/Mn/sub c/)$_{75}P_{14}B_6$ (C=0.7 to 20 at.% 1.7 to 270°K), 2:57127 (CALT-822-91)
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
BORIDES/ELECTRIC CONDUCTIVITY
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
BORIDES/MAGNETIZATION
Ferromagnetic and antiferromagnetic coupling in amorphous (Ni/sub 100-c/Mn/sub c/)$_{75}P_{14}B_6$ (C=0.7 to 20 at.% 1.7 to 270°K), 2:57127 (CALT-822-91)
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
BORN-OPPENHEIMER APPROXIMATION/CORRECTIONS
Corrections to the Born-Oppenheimer approximation in the calculation of iotope effects on equilibrium constants, 2:57223
BORON 10 TARGET/PROTON REACTIONS
Inelastic interaction of high energy particles with light nuclei and the cluster structure of nuclei (660 MeV; differential cross sections), 2:57593
BORON 11 TARGET/PROTON REACTIONS
Inelastic interaction of high energy particles with light nuclei and the cluster structure of nuclei (660 MeV; differential cross sections), 2:57593
BORON CARBIDES
Correlation for boron carbide helium release in fast reactors, 2:56724
Measurement of tritium retention in fast-neutron-irradiated boron carbide, 2:56725
BOUNDARY LAYERS/TWO-PHASE FLOW
Investigation of drop settlement in two-phase boundary layer of a short plate, 2:57301
BOUNDARY-VALUE PROBLEMS/NUMERICAL SOLUTION
Computational solution of nonlinear two-point boundary-value problems (SUPOR Q, in FORTRAN for CDC 6600), 2:57814 (SAND-76-5572)
INGEN: a general purpose mesh generator for finite element codes, 2:57812 (LA-UR-77-1345)
BR-5 REACTOR (USSR)
See SBR-5 REACTOR
BRAIN/BLOOD FLOW
Four-dimensional reconstruction of radioisotopic activity in the brain, 2:57420
BRAIN/IMMUNITY
Studies in developmental immunogenetics. Annual progress report, 2:57406 (CALT-767P6-X12)
BRAKING RADIATION
See BREMSSTRAHLUNG
BREEDER REACTORS
See also GCFR TYPE REACTORS
LMFBR TYPE REACTORS
BREEDER REACTORS/ECONOMICS
To breed or not to breed, 2:56553
BREEDER REACTORS/FUEL CYCLE
Relationships between nuclear growth rates and breeder doubling times, 2:56546
BREEDING BLANKETS/DESIGN
Catalyzed D-D and D-^{3}He fusion blanket designs, 2:57727
First wall and blanket design for an ICTR, 2:57781
Low maintenance, low pressure, low radioactivity graphite blanket concept for fusion reactors, 2:57725
BREEDING BLANKETS/HEAT TRANSFER
Conduction-cooled minimum activity blankets for TNS and EPR fusion reactors, 2:57746
BREEDING BLANKETS/HYBRID SYSTEMS
Parameter matching for the breeding blanket, 2:57728
BREEDING BLANKETS/LOSS OF COOLANT
Loss-of-coolant accidents in lithium-cooled fusion blankets, 2:57744
BREEDING BLANKETS/MAINTENANCE
Low maintenance, low pressure, low radioactivity graphite blanket concept for fusion reactors, 2:57725
BREEDING BLANKETS/PERMEABILITY
Mathematical models for transport of tritium and helium-4 in solid breeders, 2:57765
BREEDING BLANKETS/THERMAL STRESSES
Fusion blanket first-wall time-dependent thermal stress model, 2:57730
BREEDING BLANKETS/THERMOSYPHON EFFECT
Thermal-hydraulic and neutronics analysis of an SAP-thermosyphon blanket, 2:57729
BREMSSTRAHLUNG/STOKES PARAMETERS
Polarization characteristics of coherent bremsstrahlung with off-axis collimation, 2:57572

BREMSSTRAHLUNG (MAGNETIC)
See SYNCHROTRON RADIATION
BRINES/CORROSIVE EFFECTS
Geothermal power plants and their material trends, 2:56202
Nitinol self-descaling surface for geothermal scale control, 2:56201 (LBL-6324)
BRINES/FLASHING
Method of removing dissolved non-condensibles from geothermal brines (Patent), 2:56199
BRITISH GAS CORPORATION PROCESS
See CRG PROCESSES
BROMINATED ALIPHATIC HYDROCARBONS/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
BRONZE/CATALYTIC EFFECTS
Surface and electrocatalytic properties of tungsten bronzes, 2:57129 (IS-M-96)
BROWN COAL/SURFACE MINING
Brown coal: open pit technique reaches new order of magnitude, 2:55683
BROWNS FERRY-1 REACTOR/REACTOR NOISE
Noise diagnostics for safety assessment quarterly progress report, January-March 1977, 2:56368 (ORNL/NUREG/TM-112)
BROWNS FERRY-2 REACTOR/REACTOR NOISE
Noise diagnostics for safety assessment quarterly progress report, January-March 1977, 2:56368 (ORNL/NUREG/TM-112)
BROWNS FERRY-3 REACTOR/REACTOR NOISE
Noise diagnostics for safety assessment quarterly progress report, January-March 1977, 2:56368 (ORNL/NUREG/TM-112)
BUCKLING (STRUCTURAL)
See DEFORMATION
BUILDINGS
See also ANIMAL SHELTERS
APARTMENT BUILDINGS
COMMERCIAL BUILDINGS
GREENHOUSES
HOUSES
OFFICE BUILDINGS
BUILDINGS/AIR CONDITIONING
Computer-aided calculation of insolation of rooms, taking into account different shading factors, 2:57830
Design of energy-integrated building subsystems and their evaluation, 2:57012
BUILDINGS/CONSTRUCTION
First-rate prestressed concrete structures in underground workings: oceanic buildings, nuclear power plants, containers and tunnels, 2:56706
BUILDINGS/ENERGY CONSERVATION
Energy-conservation standards loom for buildings and industrial processes, 2:56942
Solar energy and energy conservation in Australian buildings, 2:56117
BUILDINGS/ENERGY CONSUMPTION
Bibliography on available computer programs in the general area of heating, refrigerating, air conditioning and ventilating. Research project, 2:57004 (PB-264904)
Energy, environment, management, and systems, 2:56984
Report from Berkeley (Summary of 1975 summer study at LBL on Efficient Use of Energy in Buildings), 2:56946
BUILDINGS/ENERGY DEMAND
Ultimate energy requirements for small consumers, 2:56953
BUILDINGS/HEAT LOSSES
Detecting structural heat losses with mobile infrared thermography. Part III. Survey of USA CRREL, 2:57003 (NP-22267)
BUILDINGS/INSOLATION
Computer-aided calculation of insolation of rooms, taking into account different shading factors, 2:57830
BUILDINGS/SAFETY STANDARDS
Proposed safety standards for ERDA trailers and other portable structures, 2:57313 (UCID-17456)
BUILDINGS/SOLAR AIR CONDITIONING
Basic solar energy balance, 2:56110
Method for estimating solar heating and cooling system performance, 2:56105
Solar energy and energy conservation in Australian buildings, 2:56117
BUILDINGS/SOLAR SPACE HEATING
Basic solar energy balance, 2:56110
Method for estimating solar heating and cooling system performance, 2:56105
Solar energy and energy conservation in Australian buildings, 2:56117
BUILDINGS/SOLAR WATER HEATERS
Solar energy and energy conservation in Australian buildings, 2:56117
BUILDINGS/SPACE HEATING
Design of energy-integrated building subsystems and their evaluation, 2:57012
Methods for conveying and utilization of waste heat from power plants, 2:56341
BUILDINGS/STRESS ANALYSIS
MODSAP: a modified version of the program SAP IV for the static and dynamic response of linear and localized nonlinear structures, 2:57808 (GA-A-14405)
BUILDINGS/VENTILATION
Comparison between regenerative and recuperative heat recovery systems in ventilating plants, 2:57045
BUNKER OILS
See RESIDUAL FUELS
BUNKERS
See HOPPERS
BURNABLE POISONS/PERFORMANCE TESTING
C-E burnable poison irradiation test program. (CEN No. 50) (PWR), 2:56721 (NP-22113)
BURNABLE POISONS/PHYSICAL PROPERTIES
Control material behavior in commercial reactors, 2:56722
BURNERS
See also COMBUSTORS
FLUIDIZED-BED COMBUSTORS
BURNERS/COMBUSTION
Investigation of stability and breakup of particles of a material during fusion in a gas suspension, 2:57321
BURNERS/DESIGN
Development of the burning process with different layouts of vortex burners, 2:57319
Operation of the furnace chamber of the tpp-312a boiler with single-tier layout of burners with the thermal capacity of 100 mw, 2:57327
BURNERS/EFFICIENCY
Preparation of liquid fuels by gas atomization, 2:57317
BURNERS/FUEL INJECTION SYSTEMS
Experimental investigation of residual fuel oil atomization by water injectors, 2:57320
BURNERS/OPERATION
Aerodynamic characteristics of swirling burners and burnout of pulverized coal spray with peripheral ignition, 2:57325
Mathematical model to study the process of combustion of a stream of atomized liquid fuel as a control object, 2:57322
BURNERS/PERFORMANCE
Investigation of stability and breakup of particles of a material during fusion in a gas suspension, 2:57321
BURNERS/PERFORMANCE TESTING
Operation of the furnace chamber of the tpp-312a boiler with single-tier layout of burners with the thermal capacity of 100 mw, 2:57327
Operation of the furnace chamber of the tpp-312a boiler with single-tier layout of burners with the thermal capacity of 100 mw, 2:57327
BURNERS/TESTING
Operation of the furnace chamber of the tpp-312a boiler with single-tier layout of burners with the thermal capacity of 100 mw, 2:57327
BURST CAN MONITORS
See FAILED ELEMENT MONITORS
BURST SLUG MONITORS
See FAILED ELEMENT MONITORS
BUSES/PERFORMANCE
Small bus program: vehicle operation efficiency report. Part I. experimental bus program (15-20 passenger buses). Part II. Van conversions for dial-a-ride service (12 passenger buses), 2:56941 (PB-265131)
BUTANE/TRANSPORT
Some problems of hydraulic calculation of gas pipelines transporting gas and air mixture, 2:55824
BWR TYPE REACTORS
See also BLACK FOX-1 REACTOR
BROWNS FERRY-1 REACTOR
BROWNS FERRY-2 REACTOR
BROWNS FERRY-3 REACTOR
HAMAOKA-1 REACTOR
HOPE CREEK-1 REACTOR
HOPE CREEK-2 REACTOR
OKG-1 REACTOR
PHIPPS BEND-1 REACTOR
PHIPPS BEND-2 REACTOR
RWE-BAYERNWERK REACTOR
WNP-2 REACTOR
BWR TYPE REACTORS/AUXILIARY WATER SYSTEMS
Water supply system (Patent; BWR), 2:56405
BWR TYPE REACTORS/CONTAINMENT SYSTEMS
Nuclear reactor with a containment and reactor pressure vessel and a pressure suppression vessel arranged in the containment (Patent; BWR), 2:56393

Reactor containment analysis for BWR suppression systems. Progress report for January-March 1977, 2:56795 (UCRL-50045-77-1)
BWR TYPE REACTORS/CORE FLOODING SYSTEMS
Self-initialization of the RELAP4 momentum equation, 2:56811
BWR TYPE REACTORS/ECCS
Assessment of emergency core cooling system effectiveness for light water nuclear power reactors, 2:56881
BWR TYPE REACTORS/EXCURSIONS
Cladding temperatures, deformations, and failure thresholds during power bursts, 2:56807
BWR TYPE REACTORS/FAILED ELEMENT MONITORS
Apparatus for inspecting failed fuel (Patent), 2:56399
Apparatus for inspecting failed fuel (Patent; BWR), 2:56400
Method and apparatus for failed fuel detection (Patent; BWR), 2:56402
BWR TYPE REACTORS/FAILURES
Investigation of operating conditions of nuclear power plants during emergency shortages of power in the electric power system, 2:56389
BWR TYPE REACTORS/FEEDWATER
Water chemistry in Swedish boiling water reactors: operational experience, 2:56376
BWR TYPE REACTORS/FUEL ASSEMBLIES
Fuel assembly (Patent; BWR), 2:56404
Fuel assembly in a reactor (Patent; BWR), 2:56401
Fuel assembly (Patent; BWR), 2:56403
BWR TYPE REACTORS/FUEL CYCLE
Investigation of conditions of operation of nuclear power plants with water-cooled power reactors, 2:56394
Nuclear fuel cycle: (4) the reactors, 2:56606
BWR TYPE REACTORS/FUEL ELEMENT CLUSTERS
On two-phase thermal boundary layer along heated walls, 2:56395
BWR TYPE REACTORS/FUEL ELEMENTS
FRAP-S2: a computer code for the steady state analysis of oxide fuel rods, 2:56369 (TREE-NUREG-1107)
Release of fission gas from high-burnup fuel during transient heating, 2:56372
BWR TYPE REACTORS/FUEL MANAGEMENT
Code to assist in teaching nuclear fuel management, 2:56622
Investigation of conditions of operation of nuclear power plants with water-cooled power reactors, 2:56394
Optimal in-core fuel management for boiling water reactors, 2:56371
BWR TYPE REACTORS/FUEL PELLETS
Effect of pellet cracking on light water reactor fuel temperatures, 2:56392
BWR TYPE REACTORS/IN CORE INSTRUMENTS
Neutron-flux instrumentation for a boiling water reactor, 2:56391
BWR TYPE REACTORS/LOSS OF COOLANT
Analysis of LWR post-LOCA gamma ray energy redistribution, 2:56806
Analysis of Standard Problem 2 with the TRAC-1D Code, 2:56812
Behavior of inner surface oxidation of the zircaloy cladding tube in a loss-of-coolant accident, 2:56783 (JAERI-M-6602)
Oxygen concentration distribution in β-phase of the Zry-4 cladding during Zr-steam reaction at LOCA, 2:56781 (JAERI-M-6538)
BWR TYPE REACTORS/NEUTRON DETECTORS
Neutron-flux instrumentation for a boiling water reactor, 2:56391
BWR TYPE REACTORS/OFF-PEAK ENERGY STORAGE
Energy storage in the form of latent heat, 2:56388
BWR TYPE REACTORS/PIPES
Characteristics of pipe system failures in light-water reactors, 2:56861
Fracture in straight pipes under large deflection conditions. II. Pipe pressures, 2:56374
BWR TYPE REACTORS/PRESSURE VESSELS
Fatigue behavior of nozzles of light water reactor pressure vessel model, 2:56387
High pressure vessel flange behavior under transient thermal loadings, 2:56384
Improvement of fracture toughness in reactor pressure vessel steel plates, 2:56385
Novel design for LWR pressure vessel nozzles and corresponding stress analysis, 2:56383
Significance of reheat cracks to the integrity of pressure vessels for light-water reactors, 2:56367 (ORNL/NUREG-15)
Treatment of the influence of irradiation in design and operation control of pressure vessels of pressurized- and boiling-water reactors, 2:56380
BWR TYPE REACTORS/RADIOACTIVE EFFLUENTS
Airborne iodine-131 released from boiling water reactor plant, 2:56377
BWR TYPE REACTORS/REACTOR COMPONENTS
Assessment of toughness and cracking in the heat-affected zone of light water reactor components, 2:56386
BWR TYPE REACTORS/REACTOR COOLING SYSTEMS
Behavior of active products of corrosion in the system of a channel-type boiling-water nuclear power reactor of a single-loop nuclear power plant, 2:56379
Method of detecting and correcting reactor water level (Patent; BWR), 2:56406
Output control system in a boiling water atomic power plant (Patent), 2:56737
BWR TYPE REACTORS/REACTOR OPERATION
Investigation of conditions of operation of nuclear power plants with water-cooled power reactors, 2:56394
Investigation of operating conditions of nuclear power plants during emergency shortages of power in the electric power system, 2:56389
Nuclear power plant operating experience, 1974-1975, 2:56586 (PB-265794)
Operating U.S. power reactors, 2:56382
BWR TYPE REACTORS/REACTOR SAFETY
Evaluation of human errors in commercial light-water reactors, 2:56859
Reports on the research projects in the field of reactor safety sponsored by the Federal Ministry of Science and Technology. Period under report: July 1st to September 30th, 1976, 2:56779 (IRS-F-33)
BWR TYPE REACTORS/SAFETY ENGINEERING
Systems engineering applications for safety models in nuclear reactors, 2:56879
BWR TYPE REACTORS/SPENT FUEL STORAGE
High-density fuel storage for boiling water reactors, 2:56370
Spent nuclear fuel: prospects for output, storage and reprocessing, 2:56373
BWR TYPE REACTORS/SPENT FUELS
Spent nuclear fuel: prospects for output, storage and reprocessing, 2:56373

C

CADARACHE RAPSODIE REACTOR
See RAPSODIE REACTOR
CADMIUM/BIOLOGICAL ACCUMULATION
Effect of calcium on cadmium uptake by the shore crab Carcinus maenas, 2:57449
Effect of salinity on cadmium uptake by the tissues of the shore crab Carcinus maenas, 2:57451
Uptake of cadmium into the haemolymph of the shore crab Carcinus maenas: the relationship with copper and other divalent cations, 2:57450
CADMIUM/BIOLOGICAL EFFECTS
Genetic influence on hypertension induced by cadmium in Dahl hypertension-resistant and hypertension-sensitive rats, 2:57427
CADMIUM/ECOLOGICAL CONCENTRATION
Fate of nuclides in natural water systems. Annual progress report, October 1, 1976-September 30, 1977 (Natural ^{234}Th and ^{210}Po tracer studies of trace metal cycling in coastal waters), 2:57353 (COO-3573-26)
CADMIUM/UPTAKE
Effects of environmental factors on radiocadmium uptake by four species of marine bivalves, 2:57447
CADMIUM/X-RAY FLUORESCENCE ANALYSIS
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57198 (LA-6869-MS)
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57197 (LA-6869)
CADMIUM SULFIDE SOLAR CELLS/EFFICIENCY
Advances in the development of efficient thin film CdS/Cu_2S solar cells, 2:56044 (TID-27697)
CADMIUM SULFIDE SOLAR CELLS/FABRICATION
Advances in the development of efficient thin film CdS/Cu_2S . solar cells, 2:56044 (TID-27697)
$CuInSe_2$/CdS thin film solar cells, 2:56073
Fabrication of thin film Cu_2S/CdS solar cells by a novel evaporation technique, 2:56051
High efficiency n-CdS/p-InP solar cells prepared by the close-spaced technique, 2:56050
Studies related to Zn/sub x/Cd/sub 1-x/S solar cells. Technical report IEC/PV/TR/76/4, 2:56028 (CONF-761130-4)
CADMIUM SULFIDE SOLAR CELLS/MATHEMATICAL MODELS
CdS/Cu_2S heterojunction model, 2:56072
CADMIUM SULFIDE SOLAR CELLS/PERFORMANCE
CdS/Cu_2S solar cells: a low-cost thin film polycrystalline photovoltaic device for terrestrial applications, 2:56070
$CuInSe_2$/CdS thin film solar cells, 2:56073
CADMIUM SULFIDE SOLAR CELLS/PRODUCTION
Initial production of CdS photovoltaic products, 2:56069

CALANDRIAS/STRESS ANALYSIS
Finite element analysis of reactor support diaphragm for elastic instability (PHWR), 2:56465
CALCIUM/BIOLOGICAL EFFECTS
Effect of calcium on cadmium uptake by the shore crab Carcinus maenas, 2:57449
CALCIUM/ELECTRON COLLISIONS
Investigation of plasmon excitation by oblique incidence of a beam of primary electrons of medium energy in reflection experiments (50 to 500 eV, 0 to 88°), 2:57498
CALCIUM 48 REACTIONS/COMPOUND-NUCLEUS REACTIONS
Search for superheavy elements in the bombardment of ^{248}Cm with ^{48}Ca, 2:57601
CALCIUM CHLORIDES/UPTAKE
Nitrate uptake by dark-grown corn seedlings. Some characteristics of apparent induction, 2:57419
CALCIUM COMPLEXES/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance studies of diamagnetic metal-aminopolycarboxylate complexes, 2:57229
CALCIUM COMPOUNDS/OXIDATION
Oxidation behavior of nickel-chromium-aluminum-yttrium - magnesium oxide and nickel-chromium-aluminum-yttrium - zirconate type of cermets, 2:57163 (N-77-16115)
CALCIUM NITRATES/UPTAKE
Nitrate uptake by dark-grown corn seedlings. Some characteristics of apparent induction, 2:57419
CALCIUM OXIDES/WETTABILITY
Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R-1746)
CALDERAS/GEOPHYSICAL SURVEYS
Heat discharge measurement and geophysical prospecting at Nigorikawa basin, northern part of Komagatake, 2:56183
CALDERAS/TEMPERATURE MEASUREMENT
Heat discharge measurement and geophysical prospecting at Nigorikawa basin, northern part of Komagatake, 2:56183
CALIBRATION STANDARDS/CHEMICAL PREPARATION
Progress report for the Division of Safeguards and Security: July-December 1976, 2:55955 (MLM-2429)
CALIFORNIA
See also IMPERIAL VALLEY
CALIFORNIA/ELECTRIC POWER
Impacts of the western drought on regional electricity generation. Interim report, 2:56975 (PB-265 641)
CALIFORNIA/INSOLATION
Analysis of the California solar resource, 2:56138
CANADA
See also ALBERTA
CANADA/ECONOMIC POLICY
Mineral industry in the Canadian economy: review and outlook, 2:56920
CANADA/GEOLOGICAL SURVEYS
Middle--upper Devonian clastic wedge of the Franklinian geosyncline, 2:55750
CANADA/GROSS NATIONAL PRODUCT
Mineral industry in the Canadian economy: review and outlook, 2:56920
CANADA/MINERAL INDUSTRY
Canadian non-fuel minerals in the international scene and foreign policy, 2:56932
Canadian reserves of seven metals, 2:56933
Mineral industry in the Canadian economy: review and outlook, 2:56920
Regional mineral developments, 2:56931
CANADA/NATURAL GAS INDUSTRY
Business systems for hydrocarbon resources: their credibility in retrospect and in prospect, 2:55816
Metricating the crude oil and natural gas industry, 2:55703
CANADA/NUCLEAR INDUSTRY
Technology transfer: its contribution to the Canadian nuclear industry, 2:56633
CANADA/PETROLEUM INDUSTRY
Business systems for hydrocarbon resources: their credibility in retrospect and in prospect, 2:55816
Metricating the crude oil and natural gas industry, 2:55703
CANADA/URANIUM DEPOSITS
Uranium exploration '75, 2:55853
CANCER
See NEOPLASMS
CANDU TYPE REACTORS/FUEL CYCLE
Future routes for Canada's nuclear effort, 2:56462
Impact of thermal near-breeders on uranium utilization, 2:56600
Nuclear fuel cycle: (4) the reactors, 2:56606
CANDU TYPE REACTORS/FUEL ELEMENTS
CANDU fuel: power ramp performance criteria, 2:56460
CANDU TYPE REACTORS/GASKETS
Compressibility and compliance of spiral wound gaskets, 2:56464
CANDU TYPE REACTORS/PUMPS
End face seals in high pressure water--learning from those failures, 2:56473
CANDU TYPE REACTORS/REACTOR CONTROL SYSTEMS
Controllability studies for an advanced CANDU boiling light water reactor, 2:56731
CANDU TYPE REACTORS/REACTOR KINETICS
Controllability studies for an advanced CANDU boiling light water reactor, 2:56731
CANDU TYPE REACTORS/TECHNOLOGY TRANSFER
Heavy water reactor best option for technology transfer, 2:56461
CANONICAL EQUATIONS
See DIFFERENTIAL EQUATIONS
CAPILLARY FLOW/THREE-DIMENSIONAL CALCULATIONS
Modelling pore structure by 2-D and 3-D networks with application to sandstones, 2:57465
CAPILLARY FLOW/TWO-DIMENSIONAL CALCULATIONS
Modelling pore structure by 2-D and 3-D networks with application to sandstones, 2:57465
CAPITAL/INVESTMENT
Accommodation in the international capital markets and the recycling of oil funds. Working paper, 2:56917 (PB-265113)
CARBON
See also GRAPHITE
PYROLYTIC CARBON
CARBON/COMBUSTION
Combustion of carbon. Effect of sulfur dioxide, 2:55804
CARBON/ION-ATOM COLLISIONS
Long-range interactions of ions with atoms having partially filled p subshells (Born-Oppenheimer approximation), 2:57513
CARBON/NEUTRON REACTIONS
Comments on the energy-averaged total neutron cross sections of structural materials in the few MeV range, 2:57591 (ANL/NDM-33)
CARBON/NUCLEAR REACTION ANALYSIS
Use of $^{13}C(d,p)^{13}C$ and $^{16}O(d,p)^{17}O$ reactions, 2:57189 (SAND-77-0366C)
CARBON 12/DISTRIBUTION
Use of $^{13}C(d,p)^{13}C$ and $^{16}O(d,p)^{17}O$ reactions, 2:57189 (SAND-77-0366C)
CARBON 12 REACTIONS/FISSION
Large collision residues and nuclear fission in the interaction of 25.2-GeV ^{12}C with uranium, 2:57604
CARBON 12 REACTIONS/PRECOMPOUND-NUCLEUS EMISSION
Large collision residues and nuclear fission in the interaction of 25.2-GeV ^{12}C with uranium, 2:57604
CARBON 12 TARGET/PROTON REACTIONS
Inelastic interaction of high energy particles with light nuclei and the cluster structure of nuclei (660 MeV; differential cross sections), 2:57593
CARBON 13/BIOLOGICAL EFFECTS
Isotope chemistry and biology, 2:57438
CARBON 14/RADIATION MONITORING
Sensitive method for continuous air monitoring for ^{14}C and ^{3}H, 2:57374 (MLM-2441(TR))
CARBON DIOXIDE/CHEMICAL REACTION YIELD
Present and future production of CO_2 from fossil fuels: a global appraisal (6 refs), 2:55656 (ORAU/IEA(O)-77-15)
CARBON DIOXIDE/CONTROL
Present and future production of CO_2 from fossil fuels: a global appraisal (6 refs), 2:55656 (ORAU/IEA(O)-77-15)
CARBON DIOXIDE/ENERGY LEVELS
Theoretical studies of the atmospheric triatomic molecules H_2O, N_2O, NO_2, CO_2, O_3, and their ions, 2:57501 (ANL-77-3)
CARBON DIOXIDE/ENVIRONMENTAL IMPACTS
Present and future production of CO_2 from fossil fuels: a global appraisal (6 refs), 2:55656 (ORAU/IEA(O)-77-15)
CARBON DIOXIDE/MOLECULE-MOLECULE COLLISIONS
Study of momentum transfer distributions in rotationally inelastic collisions (Peripheral collisions, anisotropy), 2:57551
CARBON DIOXIDE LASERS/EXCITATION
Generation of nanosecond pulses in high-pressure CO_2 lasers, 2:57294
CARBON DIOXIDE LASERS/POPULATION INVERSION
Population inversion for $10^0 0\text{-}01^1 0$ and $02^0 0\text{-}01^1 0$ transitions of the CO_2 molecule with gasdynamic cooling, 2:57292
CARBON DIOXIDE LASERS/RESEARCH PROGRAMS
Laser fusion technology and experiments, 2:57775
CARBON IONS/COLLISIONS
Model of secondary electron yields from atomic and polyatomic ion impacts on copper and tungsten surfaces based upon stopping-power calculations, 2:57495
CARBON MONOXIDE/CHEMICAL RADIATION EFFECTS
Substituting polyketones and polysulfones for polyethylene, 2:57171

CARBON MONOXIDE/MONITORING
Individual air pollution monitors. 2. Examination of some nonoccupational research and regulatory uses and needs, 2:57352 (BNL-50637)
CARBON MONOXIDE LASERS/ELECTRIC DISCHARGES
Mass spectra of the positive ions in the discharge plasma of CO and N_2O lasers, 2:57295
CARBONACEOUS MATERIALS/GASIFICATION
Production of clean synthesis or fuel gas (Patent; from liquid hydrocarbonaceous fuels such as petroleum or its products, coal products, shale oils, or slurry of solid carbonaceous fuel), 2:55988
Production of clean synthesis or fuel gas (Patent; from liquid hydrocarbonaceous fuels such as petroleum or its products, coal products, shale oils, or slurry of solid carbonaceous fuel), 2:55989
Production of clean synthesis or fuel gas (Patent; by-product steam), 2:55990
CARBONATE ROCKS/LITHOLOGY
Paleozoic carbonate formations in the south-east of Russian Platform and their oil and gas potential, 2:55752
CARBOXYLIC ACID ESTERS
See also ACETIC ACID ESTERS
CITRIC ACID ESTERS
CARBOXYLIC ACID ESTERS/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
CARCINOGENESIS
Radiation carcinogenesis. Progress report IV, 15 March 1976-15 May 1977 (Abscopal effects of radiation on parabiant rats), 2:57435 (COO-3017-31)
CARCINOGENS/BIOLOGICAL EFFECTS
Organ culture-cell culture system for studying multistage carcinogenesis in respiratory epithelium (Mice), 2:57453 (CONF-770342-2)
CARDIAC PACEMAKERS/PERFORMANCE
Functional and structural performances of radioisotope power sources for artificial heart, 2:55972
CASKS/DESIGN
Design of containers for shipping unirradiated LMFBR assemblies, 2:57275 (DP-MS-77-5)
CASKS/EVALUATION
Safety Analysis Report for Packaging (SARP): ATMX-500 Railcar nuclear packaging, 2:57277 (MLM-2428)
CASKS/MECHANICAL VIBRATIONS
Shock and vibration environments for large shipping containers on rail cars and trucks, 2:57278 (SAND-76-0427)
CASKS/SAFETY
Safety analysis report on the "Paducah Tiger" protective overpack for 10-ton cylinders of uranium hexafluoride. Supplement 1, 2:57276 (KY-665(Suppl.1))
CATALYSTS/COMPARATIVE EVALUATIONS
Catalytic hydrogenation of coal-derived liquids. Interim report, March 1977-May 1977 (Co molybdate), 2:55556 (FE-2034-7)
CATALYSTS/DEACTIVATION
Surface structure and mechanisms of gasification catalyst deactivation. Annual report, February 1976-January 1977 (Ni coprecipitated catalysts), 2:55574 (FE-2229-4)
CATALYSTS/PARTICLE SIZE
Gas generator research and development: BI-GAS process. Quarterly report, January-March 1977, 2:55567 (FE-1207-29)
CATALYSTS/STRUCTURAL CHEMICAL ANALYSIS
Surface structure and mechanisms of gasification catalyst deactivation. Annual report, February 1976-January 1977 (Ni coprecipitated catalysts), 2:55574 (FE-2229-4)
CATALYTIC CONVERTERS/CATALYSTS
Process for preparing catalytic materials for purifying exhaust gas and catalytic materials prepared thereby (Patent), 2:57083
CATALYTIC RICH GAS PROCESS
See CRG PROCESSES
CATARACTS/RADIOINDUCTION
Biochemical studies on the ocular lens in relation to cataractogenesis. Progress report, July 1, 1975-May 31, 1977 (X radiation), 2:57434 (COO-2012-27)
Radiation carcinogenesis. Progress report IV, 15 March 1976-15 May 1977 (Abscopal effects of radiation on parabiant rats), 2:57435 (COO-3017-31)
CATHODES/EROSION
Investigation of cathode spots in the presence of slag films on open-cycle MHD-generator electrodes, 2:56995
CDC COMPUTERS/COMPUTER CALCULATIONS
Implementation of the large mathematical model HEMP on the STAR-100 computers, 2:57822 (UCRL-52277)
CDC COMPUTERS/MATHEMATICAL MODELS
Queueing network models of computer systems with limited parallelism in subnetworks (6000 series), 2:57811 (LA-UR-77-894)
CE STANDARD REACTOR
(Prior to 1975, PWR/80 TYPE REACTORS was used.)
CE STANDARD REACTOR/ECCS
Best-judgment analysis of emergency core cooling system performance, 2:56798
CELL CONSTITUENTS
See also CYTOPLASM
CELL CONSTITUENTS/BIOCHEMISTRY
Mechanisms of innate immunity: cytoplasmic granules of polymorphonuclear neutrophilic granulocytes, antimicrobial action, translocation, role, and fate in antimicrobial phagocytosis. Progress report, March 1976-June 30, 1977, 2:57413 (ORO-3628-11)
CELL FLOW SYSTEMS/SAMPLE PREPARATION
Flow microfluorometric and spectrophotofluorometric analysis of DNA staining in mammalian cells, 2:57416 (LA-UR-77-365)
CELLS (ANIMAL)
See ANIMAL CELLS
CELLS (BACTERIAL)
See BACTERIA
CENTRAL RECEIVERS/PERFORMANCE TESTING
Preliminary test report, 10 KWt solar energy receiver. Test period, July 31, 1976-August 27, 1976, 2:56085 (COO-2823-1)
CENTRIFUGAL FAST ANALYZERS/PERFORMANCE TESTING
New portable centrifugal fast analyzer with expanded versatility, 2:57201 (CONF-770332-1)
CERAMICS/MANUFACTURING
Needs and opportunities for ceramic science and technology, 2:57032 (COO-2390-15)
CEREALS/SOLAR DRYING
Solar energy applications in agriculture: potential, research needs, and adoption strategies, 2:56092 (PB-265105)
CERRO PRIETO GEOTHERMAL FIELD/BRINES
Geothermal power plants and their material trends, 2:56202
CERRO PRIETO GEOTHERMAL FIELD/GEOTHERMAL FLUIDS
Geothermal power plants and their material trends, 2:56202
CESIUM 137/ENVIRONMENTAL TRANSPORT
Finite element models for sediment and contaminant transport in surface waters. Transport of sediments and radionuclides in the Clinch River (^{137}Cs, ^{90}Sr, ^{198}Au), 2:57398 (BNWL-2227)
CESIUM 137/RADIOECOLOGICAL CONCENTRATION
Concentrations of radionuclides and selected stable elements in fruits and vegetables, 2:57381 (CONF-770676-1)
CHAR OIL ENERGY DEVELOPMENT PROCESS
See COED PROCESS
CHARGED PARTICLES
See also IONS
CHARGED PARTICLES/LEVITATION
Polarized particle levitation in hexapole field, 2:57770 (UCRL-13735-2)
CHARM PARTICLES/REVIEWS
From the psi to charm: the experiments of 1975 and 1976, 2:57568
CHARMONIUM/ENERGY-LEVEL TRANSITIONS
Radiative transitions in the charmonium model, 2:57573
CHARS/SYNTHESIS
Pyrolysis process for converting refuse to fuel gas (Patent; optimization of Purox Pyrolysis Process), 2:55993
CHEMICAL EFFLUENTS/ENVIRONMENTAL EFFECTS
Report of a workshop on the impact of thermal power plant cooling systems on aquatic environments, Asilomar, Pacific Grove, California, September 28-October 2, 1975. Volume I. Working group results, 2:57401 (EPRI-SR-38(Vol.1))
CHEMICAL EFFLUENTS/ENVIRONMENTAL TRANSPORT
Chloro-organics in surface water sources for potable water, 2:57388 (CONF-770552-1)
Fate of nuclides in natural water systems. Annual progress report, October 1, 1976-September 30, 1977 (Natural ^{234}Th and ^{210}Po tracer studies of trace metal cycling in coastal waters), 2:57353 (COO-3573-26)
CHEMICAL EFFLUENTS/TOXICITY
Toxicity of some of the organic emissions identified in the effluents from reprocessing nuclear fuel, 2:55938
CHEMICAL EXPLOSIVES
See also TATB
CHEMICAL EXPLOSIVES/DETONATIONS
Empirical model to compute the velocity histories of flyers driven by electrically exploding foils, 2:57249 (LA-6809)
CHEMICAL EXPLOSIVES/PERFORMANCE TESTING
Equations of state for detonation products of high energy PBX explosives, 2:57348 (UCID-17540)
Explosive testing at the Lawrence Livermore Laboratory: philosophy and practice, 2:57349 (UCRL-79391)
CHEMICAL EXPLOSIVES/THERMAL DEGRADATION
LASL methods for derivation of predictive models for explosives thermal hazards and lifetime, 2:57346 (LA-UR-77-1378)
CHEMICAL FEEDSTOCKS
See also PETROCHEMICALS

CHEMICAL FEEDSTOCKS/SYNTHESIS
Synthetic carbonaceous fuels and feedstocks from oxides of carbon and nuclear power, 2:55981 (BNL-22785)
CHEMICAL INDUSTRY
See also MINERAL INDUSTRY
CHEMICAL INDUSTRY/PETROCHEMICAL PLANTS
Structural change in feedstocks supply for the petrochemicals industry, 2:55778
CHEMICAL INDUSTRY/RESOURCE CONSERVATION
Complex utilization of raw materials and materials by chemical industry in conditions of automated norm-setting system of the azerbaijan republic, 2:57033
CHEMICAL REACTION KINETICS/ISOTOPE EFFECTS
Isotope effects and reaction mechanisms, 2:57226
CHEMICAL REACTIONS
See also CORROSION
FISCHER-TROPSCH SYNTHESIS
HYDROGENATION
CHEMICAL REACTIONS/TUNNEL EFFECT
Isotope effects and quantum-mechanical tunneling, 2:57222
CHEMICAL REACTORS/DESIGN
Material manufacturing and fabrication of ultra-large size hydrodesulphurization reactors, 2:57263
CHEMICAL REACTORS/FABRICATION
Material manufacturing and fabrication of ultra-large size hydrodesulphurization reactors, 2:57263
CHEMICAL REACTORS/PERFORMANCE
Thermodynamic estimation of the minimum concentration attainable in a flow-through porous electrode reactor, 2:57048
CHEMICAL REACTORS/TWO-PHASE FLOW
Synthoil hydrodynamics. Final report, 2:55600 (COO-0056-4)
CHESAPEAKE BAY/COMPARATIVE EVALUATIONS
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)
CHESAPEAKE BAY/SEDIMENTS
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)
CHESAPEAKE BAY/SURFACE WATERS
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)
CHLORINATED ALIPHATIC HYDROCARBONS/ELECTRON-MOLECULE COLLISIONS
Fragmentation of aliphatic chlorocarbons under low-energy (< or approx. = 10 eV) electron impact, 2:57512
CHLORINATED ALIPHATIC HYDROCARBONS/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
CHLORINATED AROMATIC HYDROCARBONS/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
CHLORINE/BIOLOGICAL EFFECTS
Effect of chlorine toxicity on certain blood parameters of adult rainbow trout (Salmo gairdneri), 2:57456
CHLORINE/ENVIRONMENTAL EFFECTS
Report of a workshop on the impact of thermal power plant cooling systems on aquatic environments, Asilomar, Pacific Grove, California, September 28-October 2, 1975. Volume I. Working group results, 2:57401 (EPRI-SR-38(Vol.1))
CHROMATES/CATALYTIC EFFECTS
Molding of a low-temperature catalyst for methanol synthesis, 2:55995
CHROMATIN/FIBERS
ν bodies are close-packed in chromatin fibers, 2:57412 (CONF-770648-2)
CHROMATIN/MOLECULAR STRUCTURE
Conformational states of chromatin, 2:57411 (CONF-770648-1)
CHROMATOGRAPHY
Developing empirical correlations from basic GPC data and deriving of fundamental GPC parameters for a given system, 2:57206 (BERC/RI-76/14)
CHROMIUM/ELECTROPLATING
Development of low-cost procedures for application of solar selective black chrome, 2:56137
Sharing the Sun: solar technology in the seventies. Volume 6, 2:56136
CHROMIUM ALLOYS
See also CHROMIUM-NICKEL STEELS
INCONEL 671
STAINLESS STEELS
STELLITE
VITALLIUM
CHROMIUM ALLOYS/AGING
Characterization and aging kinetics study of gamma prime strengthened Fe-Cr-Ni experimental alloys for breeder reactors, 2:57119 (WARD-AD-3045-5)
CHROMIUM ALLOYS/OXIDATION
Oxidation behavior of nickel-chromium-aluminum-yttrium - magnesium oxide and nickel-chromium-aluminum-yttrium - zirconate type of cermets, 2:57163 (N-77-16115)
CHROMIUM CARBIDES/FRICTION
Corrosion and tribological investigations of chromium carbide coatings for sodium cooled reactor applications, 2:56494 (CONF-760503-P1)
CHROMIUM-MOLYBDENUM STEELS/CORROSION
Investigation of high-temperature reactor heat exchanger materials, 2:56431
CHROMIUM-MOLYBDENUM STEELS/CORROSION RESISTANCE
Sodium environment effects to structural materials for fast reactors, 2:56540 (PNC-J-225-76-02)
CHROMIUM-MOLYBDENUM STEELS/CREEP
Creep and rupture behavior of a bainitic (normalized and tempered) 2 1/4 Cr-1 Mo steel, 2:57116 (ORNL-5273)
Evaluation of service life of steam turbine casings in thermal fatigue conditions, 2:56302
CHROMIUM-MOLYBDENUM STEELS/FATIGUE
Evaluation of service life of steam turbine casings in thermal fatigue conditions, 2:56302
CHROMIUM-MOLYBDENUM STEELS/HYDRIDATION
2¼Cr-1Mo steel plate with improved temper embrittlement characteristics, 2:57136
CHROMIUM-MOLYBDENUM STEELS/MECHANICAL PROPERTIES
Effect of stress concentrators on the strength of pipes of boiler heating surfaces made of 12cr1mov and Cr18Ni12Ti steel grades, 2:57124
Materials engineering issues, LMFBR steam generators, 2:56503 (CONF-760503-P1)
Prospects of improving pearlitic steels for reactor shells and other equipment of the first loop of nuclear power plants, 2:56694
Steam generator materials engineering eleventh quarterly report, January-March 1977, 2:57112 (GEFR-14029-11)
Working capacity and reliability of pipes made of steel 12Cr1MoV after long periods of operations, 2:57123
CHROMIUM-MOLYBDENUM STEELS/TENSILE PROPERTIES
2¼Cr-1Mo steel plate with improved temper embrittlement characteristics, 2:57136
Use of a modified beam in obtaining creep data in uniaxial tension and compression, 2:57109 (CONF-770807-8)
CHROMIUM-NICKEL STEELS
(Steels containing Cr and Ni; the Ni content is usually 0.5 to 2.0%, the Cr content is higher.)
See also STAINLESS STEEL-304
STAINLESS STEEL-310
STAINLESS STEEL-316
STAINLESS STEEL-321
STAINLESS STEEL-347
CHROMIUM-NICKEL STEELS/CARBURIZATION
Carburization of centrifugally cast tubes in the petrochemical industry and explanation of this behavior based on laboratory tests on Cr-Ni steels and alloys at 800 and 1150°C, 2:57135
CHROMIUM-NICKEL STEELS/CORROSION
Investigation of high-temperature reactor heat exchanger materials, 2:56431
CHROMIUM-NICKEL STEELS/MECHANICAL PROPERTIES
Effect of stress concentrators on the strength of pipes of boiler heating surfaces made of 12cr1mov and Cr18Ni12Ti steel grades, 2:57124
Prospects of improving pearlitic steels for reactor shells and other equipment of the first loop of nuclear power plants, 2:56694
CHROMIUM-NICKEL STEELS/PHYSICAL PROPERTIES
Steel grades for tubes of heating surfaces of high-capacity highly efficient boilers (EP184, EP17, EI695R), 2:57132
CHROMIUM-NICKEL STEELS/PHYSICAL RADIATION EFFECTS
Fast reactor programme; irradiation effects on the mechanical properties of 18Cr-11Ni stainless steel (DIN 1.4948, type AISI 304 ss). First status report, 2:57142 (ECN-4)
CHROMOSPHERE/RADIATION FLUX
Impulsive solar x-ray bursts. 3. Polarization and directivity of bremsstrahlung radiation from a beam of electrons directed toward the photosphere, 2:57482 (N-77-16976)
Impulsive solar x-ray bursts. 4: polarization, directivity and spectrum of the reflected and total bremsstrahlung radiation from a beam of electrons directed toward the photosphere, 2:57483 (N-77-16977)
CHUBU-1 REACTOR
See HAMAOKA-1 REACTOR

CITRIC ACID ESTERS/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
CIVIL DEFENSE/COMMUNICATIONS
Local program paper handbook (Civil defense), 2:57835 (CPG-1-5A)
CIVIL DEFENSE/DATA COMPILATION
Local program paper handbook (Civil defense), 2:57835 (CPG-1-5A)
CLAMS
See MOLLUSCS
CLEAN COKE PROCESS/HYDROGENATION
Hydrocarbonization process evaluation report. Volume II. Evaluation of process feasibility (49 refs), 2:55558 (ORNL-5213)
CLEAN COKE PROCESS/PILOT PLANTS
Hydrocarbonization process evaluation report. Volume II. Evaluation of process feasibility (49 refs), 2:55558 (ORNL-5213)
CLEAN COKE PROCESS/RECOMMENDATIONS
Hydrocarbonization process evaluation report. Volume II. Evaluation of process feasibility (49 refs), 2:55558 (ORNL-5213)
CLINCH RIVER BREEDER REACTOR/ECONOMICS
Clinch River Breeder Reactor Plant technical review, 2:56534 (CRBRP-PMC-77-03)
CLINCH RIVER BREEDER REACTOR/FLOW BLOCKAGE
Edge blockages in 19-pin sodium-cooled bundles, 2:56818
CLINCH RIVER BREEDER REACTOR/FUEL ELEMENT CLUSTERS
Edge blockages in 19-pin sodium-cooled bundles, 2:56818
CLINCH RIVER BREEDER REACTOR/FUEL ELEMENTS
Clinch River Breeder Reactor Plant. Flow induced vibration of fuel rods in CRBRP, 2:56533 (CRBRP-ARD-0166)
CLINCH RIVER BREEDER REACTOR/HEAT EXCHANGERS
Design considerations of the Clinch River Breeder Reactor Plant intermediate heat exchanger, 2:56557
CLINCH RIVER BREEDER REACTOR/LOSS OF COOLANT
Assessment of the consequences of boiling in the radial blanket due to hypothetical major pipe leaks, 2:56827
Pipe rupture studies in the Clinch River Breeder Reactor, 2:56832
CLINCH RIVER BREEDER REACTOR/LOSS OF FLOW
Loss of one heat transport loop without reactor trip, 2:56829
CLINCH RIVER BREEDER REACTOR/MELTDOWN
Assessment of CRBRP containment response to a hypothetical core melt-through accident, 2:56833
CLINCH RIVER BREEDER REACTOR/PIPES
Pipe rupture studies in the Clinch River Breeder Reactor, 2:56832
CLINCH RIVER BREEDER REACTOR/REACTOR ACCIDENTS
Sensitivity of radiological consequences to variations in aerosol parameters, 2:56820
CLINCH RIVER BREEDER REACTOR/REACTOR CORE DISRUPTION
Assessment of molten fuel motion in the CRBR shield plug following a core disruptive accident, 2:56850
Boiling pool analysis during transition to the transition phase of core disruptive accidents in LMFBRs, 2:56844
CLINCH RIVER BREEDER REACTOR/SPENT FUEL STORAGE
Design and fabrication considerations for CRBRP ex-vessel storage tank (EVST), 2:56545
CLOSED-CYCLE MHD GENERATORS/HEAT EXCHANGERS
Investigation of the high-temperature recuperator of closed-cycle power plants operating on an inert gas, 2:56992
COAL
See also BITUMINOUS COAL
BROWN COAL
COAL GASIFICATION
COAL LIQUEFACTION
SOLVENT-REFINED COAL
COAL/ACTIVATION ANALYSIS
Coal composition by ^{252}Cf neutrons and flux level corrections, 2:57192
Prompt-neutron activation analysis: applications to coal analysis, 2:57191
COAL/ALKYLATION
Coal liquefaction by alkylation (7 refs), 2:55596 (CONF-760885-)
COAL/BIBLIOGRAPHIES
Reinhardt Thiessen coal thin-section slide collection of the U.S. Geological Survey: catalog and notes (14 refs), 2:55647
COAL/BRIQUETTING
Industrialization of briquette blend coking process, 2:55552
Use of petroleum residues as binder in briquetting of coal, 2:55776
COAL/CARBONIZATION
Activation energies of carbonization of coals (6 refs), 2:55549
Engineering evaluations of coal conversion processes. Part I. Hydrocarbonization and Synthoil: information base, process selection, and preliminary evaluation of alternatives, 2:55617 (ORNL/TM-5034)
Hydrocarbonization process evaluation report. Volume II. Evaluation of process feasibility (49 refs), 2:55558 (ORNL-5213)
COAL/CHARGES
Present situation of the European Community coal mining industry, 2:56965
COAL/CHEMICAL ANALYSIS
Analysis of the aromatic content of whole coals by high-power proton decoupled C-13 NMR (15 refs), 2:55638 (CONF-760885-)
Study of the mineral matter distribution in pulverized fuel coals with respect to slag deposit formation in boiler furnaces: Phase 1. Interim report, July-September 1976, 2:55642 (FE-2316-2)
COAL/CHEMICAL COMPOSITION
Characterization of ash from coal-fired power plants. Milestone report May 75-Mar 76, 2:55649 (PB-265374)
Examination and comparison of structure: lignite, bituminous, and anthracite coal (10 refs), 2:55636 (CONF-760885-)
Inorganic sulfur in coal (12 refs), 2:55645
Study of the mineral matter distribution in pulverized fuel coals with respect to slag deposit formation in boiler furnaces: Phase 1. Interim report, July-September 1976, 2:55642 (FE-2316-2)
COAL/CHEMICAL PROPERTIES
Petrographic composition of coals: its importance in liquefaction processes, 2:55595 (CONF-760885-)
COAL/CHEMICAL REACTION KINETICS
Thermochemistry and kinetics of coal conversion, 2:55634 (CONF-760885-)
COAL/CHEMICAL REACTIONS
Chemistry of coal surfaces (7 refs), 2:55631 (CONF-760885-)
Coal catalyst, 2:55629 (AD-D-003508)
Reactions of zinc chloride and coal (23 refs), 2:55632 (CONF-760885-)
Spectral analysis of effluents from coal liquefaction processes (9 refs), 2:55597 (CONF-760885-)
COAL/CLASSIFICATION
Rapid method for source rock characterization and for determination of their petroleum potential and degree of evolution, 2:55746
Reinhardt Thiessen coal thin-section slide collection of the U.S. Geological Survey: catalog and notes (14 refs), 2:55647
COAL/COKING
Automation of coking plant servicing machines, 2:55551
Industrialization of briquette blend coking process, 2:55552
COAL/COMBUSTION
Characterization of ash from coal-fired power plants. Milestone report May 75-Mar 76, 2:55649 (PB-265374)
Development of the burning process with different layouts of vortex burners, 2:57319
Dustfree removal of electrically filtered flyash experiences with screening, 2:55651
High temperature coal and slurry combustor according to a one-dimensional flow model, 2:55722 (CONF-770530-2)
Investigation of stability and breakup of particles of a material during fusion in a gas suspension, 2:57321
Silica vaporization and condensation: a potential source of fouling in coal combustion (4 refs), 2:55650 (UCRL-79146)
COAL/COMBUSTION PRODUCTS
Radioactive residual matter. II, 2:55728
COAL/COMBUSTION PROPERTIES
Calculating heat content from ash percentages, 2:55727
Investigation of aerodynamics, ignition and burnout of spray in the furnace of a BKZ-420-140-1 boiler with twinned vortex burners of ekibastuz coal, 2:55729
Some studies in the prevention of spontaneous ignition of coals in stacks, 2:55735
COAL/CONSUMPTION RATES
Status of coal supply contracts for new electric generating units, 1976-1985, 2:56976 (PB-264769)
COAL/CUTTING
Coal planer (Patent; 13 claims), 2:55676
COAL/DESULFURIZATION
Floatability of coal and pyrite (54 references), 2:55553 (IS-T-779)
Sulfur, moisture and ash reduction in coal preparation research, 2:55554
COAL/DOCUMENTATION
Reinhardt Thiessen coal thin-section slide collection of the U.S. Geological Survey: catalog and notes (14 refs), 2:55647
COAL/ELECTROCARBONIZATION
Electrofrac's secondary oil recovery systems, 2:55756 (NP-22197)
COAL/ENERGY POLICY
Use of coal in power plants, 2:56978
COAL/FLOTATION
Floatability of coal and pyrite (54 references), 2:55553 (IS-T-779)
Technological analysis of conditions of separation of Polish gas and power coal slurries by flotation (13 refs), 2:55716
COAL/FLUIDIZED-BED COMBUSTION
Particulate analysis instrumentation for fluidized-bed combustion systems, 2:55726 (FE-2412-T-1)

Testing, identification, and evaluation of commercial and "advanced experimental" materials and coatings under design conditions simulating fuel power cycle combinations. Task II. Evaluation of heat exchanger materials for use in coal-fired fluidized bed combustion environment. Monthly technical progress report No. 14, 2:55725 (FE-2325-14)

COAL/GLOBAL ASPECTS
International coal trade, 2:56968

COAL/GOVERNMENT POLICIES
Present coal and energy policy in the European community, 2:55739

COAL/HYDRAULIC TRANSPORT
Transmission of solids by pipeline, 2:55715

COAL/HYDROGENATION
Engineering evaluations of coal conversion processes. Part I. Hydrocarbonization and Synthoil: information base, process selection, and preliminary evaluation of alternatives, 2:55617 (ORNL/TM-5034)
Homogeneous catalytic hydrogenations of complex carbonaceous substrates (16 references), 2:55555 (BNWL-SA-6055)
Phase equilibria in coal hydrogenation systems. Quarterly report, April 1977-June 1977, 2:55557 (FE-2334-5)

COAL/IGNITION
High temperature coal and slurry combustor according to a one-dimensional flow model, 2:55722 (CONF-770530-2)

COAL/IMPURITIES
Inorganic sulfur in coal (12 refs), 2:55645

COAL/INDEXES
Reinhardt Thiessen coal thin-section slide collection of the U.S. Geological Survey: catalog and notes (14 refs), 2:55647

COAL/LITHOLOGY
Reinhardt Thiessen coal thin-section slide collection of the U.S. Geological Survey: catalog and notes (14 refs), 2:55647

COAL/MATERIALS HANDLING
Development of coal-feeding systems at the Morgantown Energy Research Center (62 refs), 2:55713 (MERC/RI-77/2)

COAL/MECHANICAL PROPERTIES
Industrialization of briquette blend coking process, 2:55552

COAL/MEETINGS
Coal geology and the future. Symposium abstracts and selected references (Abstracts of 20 papers), 2:55547 (USGS-CIRC-757)
Preprints of the 1976 coal chemistry workshop, 2:55630 (CONF-760885-)

COAL/METAMORPHISM
Basaltic intrusion and its influence on coal in Seam 507 at Sosnica Colliery (12 refs), 2:55663
Reflecting power of vitrinites of Polish coals and its correlation with indices of coal class (6 refs), 2:55646

COAL/MINERALOGY
Reinhardt Thiessen coal thin-section slide collection of the U.S. Geological Survey: catalog and notes (14 refs), 2:55647

COAL/MOLECULAR STRUCTURE
Examination and comparison of structure: lignite, bituminous, and anthracite coal (10 refs), 2:55636 (CONF-760885-)
Studies on the organic structure of coals (2 refs), 2:55635 (CONF-760885-)

COAL/MONITORING
Measurements of coal slurry concentration in haulage pipelines by nuclear techniques, 2:55714

COAL/NATURAL RADIOACTIVITY
Radioactive residual matter. II, 2:55728

COAL/NUCLEAR MAGNETIC RESONANCE
^{13}C NMR studies of solid coal samples (15 refs), 2:55639 (CONF-760885-)

COAL/OXIDATION
Reflecting power of vitrinites of Polish coals and its correlation with indices of coal class (6 refs), 2:55646

COAL/PETROCHEMISTRY
Reinhardt Thiessen coal thin-section slide collection of the U.S. Geological Survey: catalog and notes (14 refs), 2:55647

COAL/PETROGENESIS
Reinhardt Thiessen coal thin-section slide collection of the U.S. Geological Survey: catalog and notes (14 refs), 2:55647

COAL/PETROLOGY
Petrographic composition of coals: its importance in liquefaction processes, 2:55595 (CONF-760885-)
Reflecting power of vitrinites of Polish coals and its correlation with indices of coal class (6 refs), 2:55646
Reinhardt Thiessen coal thin-section slide collection of the U.S. Geological Survey: catalog and notes (14 refs), 2:55647
Studies on the organic structure of coals (2 refs), 2:55635 (CONF-760885-)

COAL/PHYSICAL PROPERTIES
Petrographic composition of coals: its importance in liquefaction processes, 2:55595 (CONF-760885-)

COAL/POROSITY
Role of porous and fissiparous structure of coal in creating burst hazard situations and in mechanisms of sudden coal and gas bursts, 2:55737

COAL/RAIL TRANSPORT
Coal mine-coal conversion plant interface evaluation and conceptual design. Phase II. Monthly technical progress report, 1 April-30 April 1977, 2:55582 (FE-2370-13)
Expediency of using monorail suspended railroads with locomotive traction, 2:55709
Western coal transportation: unit trains or slurry pipelines. Final report, 2:57025 (PB-264916)

COAL/SAMPLING
Study of the mineral matter distribution in pulverized fuel coals with respect to slag deposit formation in boiler furnaces: Phase 1. Interim report, July-September 1976, 2:55642 (FE-2316-2)

COAL/SLURRY PIPELINES
Western coal transportation: unit trains or slurry pipelines. Final report, 2:57025 (PB-264916)

COAL/SOLUBILITY
Coal liquefaction by alkylation (7 refs), 2:55596 (CONF-760885-)

COAL/SPONTANEOUS COMBUSTION
Some studies in the prevention of spontaneous ignition of coals in stacks, 2:55735

COAL/STRUCTURAL CHEMICAL ANALYSIS
Application of novel NMR techniques to coal structure (4 refs), 2:55640 (CONF-760885-)

COAL/SURFACE PROPERTIES
Chemistry of coal surfaces (7 refs), 2:55631 (CONF-760885-)
Reactions of zinc chloride and coal (23 refs), 2:55632 (CONF-760885-)

COAL/TRANSPORT
Coal mine-coal conversion plant interface evaluation and conceptual design. Phase II. Monthly technical progress report, 1 April-30 April 1977, 2:55582 (FE-2370-13)

COAL/USES
Present situation of the European Community coal mining industry, 2:56965

COAL/WETTABILITY
Chemistry of coal surfaces (7 refs), 2:55631 (CONF-760885-)

COAL DEPOSITS
Semi-coking coal resources of Raniganj coalfield, 2:55666

COAL DEPOSITS/DEGASSING
Data accumulation on selected coal measures in the Warrior Basin of Alabama including search of unpublished reports and surface field mapping. Open file report, 2:55660 (PB-265182)

COAL DEPOSITS/EVALUATION
Preliminary report on 1975 drilling of lignites in western North Dakota: Adams, Bowman, Dunn, Hettinger, McLean, Mercer, Oliver, Slope, and Williams Counties, 2:55661 (USGS-OFR-76-869)

COAL DEPOSITS/EXPLORATION
Good prospects for coal in Great Britain, 2:55740

COAL DEPOSITS/GLOBAL ASPECTS
World coal resources (3 refs), 2:55662
World coal resources and the role of coal in energy savings at the end of the century, 2:56967

COAL DEPOSITS/ROCK MECHANICS
Data accumulation on selected coal measures in the Warrior Basin of Alabama including search of unpublished reports and surface field mapping. Open file report, 2:55660 (PB-265182)

COAL DEPOSITS/STRATIGRAPHY
Guidebook to coal geology of northwest New Mexico. Circular 154, 2:55659 (NP-22279)

COAL FINES/AGGLOMERATION
Selective agglomeration in the treatment of fine coal refuse, 2:55652

COAL FINES/COMBUSTION
Aerodynamic characteristics of swirling burners and burnout of pulverized coal spray with peripheral ignition, 2:57325
Comparative tests of a TP-100 boiler with closed-loop and open-loop systems of p.f. preparation when burning Lvov-Volynian pit coal, 2:56312

COAL FINES/DRYING
Tests and aerodynamic probing of TSP2 cyclones with a louvered swirler, 2:55719

COAL GASIFICATION
See also BI-GAS PROCESS
COALCON PROCESS
COED PROCESS
HYGAS PROCESS
IN-SITU GASIFICATION
LURGI PROCESS
SYNTHANE PROCESS
U-GAS PROCESS
Germany plans process heat schemes for HTGR, 2:56609
Low-Btu gas from coal has many potential markets, 2:56966
Report on coal. Status report of the Ad Hoc Committee on Energy Resources and Technology of the Atomic Industrial Forum, March 1975 (26 refs), 2:55658 (NP-22116)
Sulfidation of 310 stainless steel at sulfur potentials encountered in coal conversion systems, 2:55548 (N-76-31332)

COAL GASIFICATION/BY-PRODUCTS
Future of the coal byproducts industry, 2:55589
COAL GASIFICATION/CATALYSTS
Surface structure and mechanisms of gasification catalyst deactivation. Annual report, February 1976-January 1977 (Ni coprecipitated catalysts), 2:55574 (FE-2229-4)
COAL GASIFICATION/ECONOMICS
Status report at the end of the concept phase, 1 August 1975-30 November 1976 (Nuclear coal gasification), 2:55590 (ERDA-tr-296)
COAL GASIFICATION/IN-SITU GASIFICATION
Underground gasification offers clean safe route to coal energy, 2:56962
COAL GASIFICATION/MATERIALS
Chemical and physical stability of refractories for use in coal gasification. First annual progress report, May 1, 1976-April 30, 1977, 2:55565 (COO-2904-4)
COAL GASIFICATION/PROCESS HEAT
Materials for steam gasification of coal with HTR heat (6 refs), 2:55593
COAL GASIFICATION/TECHNOLOGY ASSESSMENT
Synthesis of substitute natural gas based on coal (21 refs), 2:55586
COAL GASIFICATION/THERMODYNAMICS
Dew points of hot gases from coal gasification processes. Quarterly report, June 1-August 31, 1976 (4 refs), 2:55571 (FE-2046-1)
Dew points of hot gases from coal gasification processes. Quarterly report, September 1-November 30, 1976 (4 refs), 2:55572 (FE-2046-2)
COAL GASIFICATION PLANTS/DESIGN
Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant. Phase II. Quarterly technical progress report, April-June 1977, 2:55568 (FE-1521-51)
Preliminary design services, coal conversion demonstration plants. Research and development report No. 114. Quarterly report, January-March 1977, 2:55569 (FE-1775-10)
COAL GASIFICATION PLANTS/FUEL FEEDING SYSTEMS
Stuffing box test procedure, 2:55581 (FE-2356-20)
COAL GASIFICATION PLANTS/PLANNING
Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant. Phase II. Quarterly technical progress report, April-June 1977, 2:55568 (FE-1521-51)
Preliminary design services, coal conversion demonstration plants. Research and development report No. 114. Quarterly report, January-March 1977, 2:55569 (FE-1775-10)
COAL GASIFICATION PLANTS/PRESSURE VESSELS
Study of heat transfer through refractory lined gasifier vessel walls. Quarterly progress report, December 1976-February 1977, 2:55573 (FE-2210-12)
COAL GASIFICATION PLANTS/REFRACTORIES
Study of heat transfer through refractory lined gasifier vessel walls. Quarterly progress report, December 1976-February 1977, 2:55573 (FE-2210-12)
COAL GASIFICATION PLANTS/SPRINGS
Coal gasification valves. Phase I. Design analysis report, 2:55578 (FE-2355-15)
COAL GASIFICATION PLANTS/VALVES
Coal gasification valves. Phase I. Component development test procedure, 2:55575 (FE-2355-12(Rev.A))
Coal gasification valves. Phase I. Stress analysis report, 2:55576 (FE-2355-13)
Coal gasification valves. Phase I. Type III valve prototype test plan, 2:55577 (FE-2355-14)
Coal gasification valves. Phase I. Design analysis report, 2:55578 (FE-2355-15)
Coal gasification valves. Phase I. Thermal analysis report, 2:55579 (FE-2355-16)
Coal gasification valves. Phase I. Thermal analysis report, 8-inch, Types I, II, and IV valves, 2:55580 (FE-2355-19)
COAL INDUSTRY
See also MINERAL INDUSTRY
Geography of energy production in France. IV. Natural regions: the inland north and Lorraine, 2:55664
COAL INDUSTRY/CAPITAL
Capital for coal development, 2:55730 (CONF-7511130-1)
COAL INDUSTRY/CONTRACTS
Status of coal supply contracts for new electric generating units, 1976-1985, 2:56976 (PB-264769)
COAL INDUSTRY/ECONOMICS
Economics of mining coal in Iowa (Economic climate in which coal industry competes), 2:55731 (IS-ICP-46)
Principal lines of development of science and technology in the tenth five-year plan period, 2:55688
COAL INDUSTRY/ENERGY POLICY
Energy policies of France Great Britain, and Germany compared, 2:56959
COAL INDUSTRY/FINANCING
Capital for coal development, 2:55730 (CONF-7511130-1)
COAL INDUSTRY/INVESTMENT
New developments in the French coal plan, 2:56963
COAL INDUSTRY/LEGAL ASPECTS
Economics of mining coal in Iowa (Economic climate in which coal industry competes), 2:55731 (IS-ICP-46)
COAL INDUSTRY/MARKET
World coal resources and the role of coal in energy savings at the end of the century, 2:56967
COAL INDUSTRY/MEETINGS
Proceedings from the workshop to identify research and data required to improve North American long-term coal supply analysis, Tampa, Florida, December 9-10, 1975, 2:55546 (EPRI-SR-36)
COAL INDUSTRY/OCCUPATIONS
Present situation of the European Community coal mining industry, 2:56965
COAL INDUSTRY/PLANNING
Contribution of coal to the energy supply of France, 2:56964
COAL INDUSTRY/PRODUCTION
New developments in the French coal plan, 2:56963
COAL INDUSTRY/RESEARCH PROGRAMS
Principal lines of development of science and technology in the tenth five-year plan period, 2:55688
COAL INDUSTRY/SOCIO-ECONOMIC FACTORS
New developments in the French coal plan, 2:56963
COAL INDUSTRY/TECHNOLOGY ASSESSMENT
Principal lines of development of science and technology in the tenth five-year plan period, 2:55688
COAL INDUSTRY/TRADE
International coal trade, 2:56968
COAL LIQUEFACTION
See also COED PROCESS
CSF PROCESS
H-COAL PROCESS
SRC-II PROCESS
SYNTHOIL PROCESS
Coal liquefaction by alkylation (7 refs), 2:55596 (CONF-760885-)
Petrographic composition of coals: its importance in liquefaction processes, 2:55595 (CONF-760885-)
Report on coal. Status report of the Ad Hoc Committee on Energy Resources and Technology of the Atomic Industrial Forum, March 1975 (26 refs), 2:55658 (NP-22116)
Spectral analysis of effluents from coal liquefaction processes (9 refs), 2:55597 (CONF-760885-)
COAL LIQUEFACTION/BY-PRODUCTS
Future of the coal byproducts industry, 2:55589
COAL LIQUEFACTION/CHEMICAL REACTION KINETICS
Application of field ionization mass spectrometry to the characterization of coal liquefaction products, 2:55598 (CONF-760885-)
COAL LIQUEFACTION/CHEMICAL REACTIONS
Chemistry of asphaltene in coal liquids (35 refs), 2:55599 (CONF-760885-)
COAL LIQUEFACTION/ECONOMIC IMPACT
Coal liquefaction: technology, impacts, and technical suitability for Montana (Extensive bibliography), 2:55614 (NP-22092)
COAL LIQUEFACTION/ENVIRONMENTAL IMPACTS
Coal liquefaction: technology, impacts, and technical suitability for Montana (Extensive bibliography), 2:55614 (NP-22092)
COAL LIQUEFACTION/RESEARCH PROGRAMS
Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels. Quarterly report, December 1976-February 1977, 2:55609 (FE-1800-12)
COAL LIQUEFACTION/REVIEWS
Coal liquefaction: technology, impacts, and technical suitability for Montana (Extensive bibliography), 2:55614 (NP-22092)
COAL LIQUEFACTION PLANTS/DESIGN
Conceptual design for advanced coal liquefaction commercial plant. Quarterly technical progress report, August 1-October 31, 1976, 2:55612 (FE-2251-14)
Evaluation of the Synthoil process. Volume I. Process design and economic evaluation of a 100,000-barrel/stream day facility, 2:55615 (ORNL-5209(Vol.1))
COAL LIQUEFACTION PLANTS/ECONOMICS
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Economic issues affecting the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55608 (FE-1752-21)
COAL LIQUEFACTION PLANTS/ENVIRONMENTAL IMPACTS
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues.

Volume III-1. Environmental considerations affecting the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55605 (FE-1752-16)
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-3. Availability of water for the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55606 (FE-1752-18)

COAL LIQUEFACTION PLANTS/EVALUATION
Evaluation of the Synthoil process. Volume I. Process design and economic evaluation of a 100,000-barrel/stream day facility, 2:55615 (ORNL-5209(Vol.1))

COAL LIQUEFACTION PLANTS/FINANCING
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Ownership issues: alternative structures for creating a commercial coal liquefaction industry. Final report, January 1975-December 1976, 2:55604 (FE-1752-15)

COAL LIQUEFACTION PLANTS/GASEOUS WASTES
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-1. Environmental considerations affecting the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55605 (FE-1752-16)

COAL LIQUEFACTION PLANTS/GOVERNMENT POLICIES
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Economic issues affecting the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55608 (FE-1752-21)

COAL LIQUEFACTION PLANTS/MANPOWER
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-5. Manpower requirements. Final report, January 1975-December 1976, 2:55607 (FE-1752-20)

COAL LIQUEFACTION PLANTS/OWNERSHIP
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Ownership issues: alternative structures for creating a commercial coal liquefaction industry. Final report, January 1975-December 1976, 2:55604 (FE-1752-15)

COAL LIQUEFACTION PLANTS/PLANNING
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. The role of synthetic liquids from coal in meeting future energy demand. Final report, January 1975-December 1976, 2:55603 (FE-1752-14)

COAL LIQUEFACTION PLANTS/REGULATIONS
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Economic issues affecting the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55608 (FE-1752-21)

COAL LIQUEFACTION PLANTS/RESIDUES
Gasification of residual materials from coal liquefaction. Quarterly report, October-December 1976, 2:55611 (FE-2247-1)

COAL LIQUEFACTION PLANTS/SOLID WASTES
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-1. Environmental considerations affecting the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55605 (FE-1752-16)

COAL LIQUEFACTION PLANTS/VALVES
Evaluation of valves for Cresap testing, 2:55602 (FE-1517-24)

COAL LIQUEFACTION PLANTS/WATER REQUIREMENTS
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-3. Availability of water for the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55606 (FE-1752-18)

COAL LIQUIDS/CHEMICAL ANALYSIS
Characterization of coal syncrudes at BERC, 2:55641 (CONF-760885-)
Investigations on the nature of preasphaltenes derived from solvent refined coal conversion products, 2:55633 (CONF-760885-)
Spectral analysis of effluents from coal liquefaction processes (9 refs), 2:55597 (CONF-760885-)

COAL LIQUIDS/CHEMICAL COMPOSITION
Application of field ionization mass spectrometry to the characterization of coal liquefaction products, 2:55598 (CONF-760885-)

COAL LIQUIDS/FRACTIONATION
Chemistry and structure of coal-derived asphaltenes, Phase II. Quarterly progress report, January-March 1977 (15 refs), 2:55610 (FE-2031-7)
Properties of coal liquids produced by the Occidental flash pyrolysis process (4 refs), 2:55618 (CONF-760885-)

COAL LIQUIDS/HYDROGENATION
Catalytic hydrogenation of coal-derived liquids. Interim report, March 1977-May 1977 (Co molybdate), 2:55556 (FE-2034-7)
Gasification of hydrocarbon feedstocks (Patent; 18 claims), 2:55985

COAL LIQUIDS/MASS SPECTROSCOPY
Application of field ionization mass spectrometry to the characterization of coal liquefaction products, 2:55598 (CONF-760885-)
Characterization of coal-derived liquids and other fossil fuel related materials employing mass spectroscopy. Quarterly report, December 30, 1976-March 29, 1977 (16 refs), 2:55643 (FE-2537-2)

COAL LIQUIDS/PRODUCTION
Hydrocarbonization process evaluation report. Volume II. Evaluation of process feasibility (49 refs), 2:55558 (ORNL-5213)
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-5. Manpower requirements. Final report, January 1975-December 1976, 2:55607 (FE-1752-20)

COAL LIQUIDS/REFINING
Characterization of coal liquids. Intermediate report for the period July-December 1975. Upgrading solvent refined coal process filter feed, 2:55624 (FE-2010-01)

COAL LIQUIDS/VISCOSITY
Gasification of residual materials from coal liquefaction. Quarterly report, October-December 1976, 2:55611 (FE-2247-1)
Investigations on the nature of preasphaltenes derived from solvent refined coal conversion products, 2:55633 (CONF-760885-)

COAL MINERS
Foreseeable developments of mining techniques in large coal-producing countries, 2:55687

COAL MINERS/ACCIDENTS
Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume I. Development and application of cost model. Final report, 2:55732 (PB-264438)

COAL MINERS/DEATH
Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume I. Development and application of cost model. Final report, 2:55732 (PB-264438)
Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume II. Program user manual. Final report, 2:55733 (PB-264439)
Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume III. Supporting data. Final report, 2:55734 (PB-264440)

COAL MINERS/INJURIES
Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume I. Development and application of cost model. Final report, 2:55732 (PB-264438)
Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume II. Program user manual. Final report, 2:55733 (PB-264439)
Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume III. Supporting data. Final report, 2:55734 (PB-264440)

COAL MINES
Determination of the probability of loosening the undermined coal seams in the light of the underground observations and theoretical consideration, 2:55695

COAL MINES/BLOWERS
Modern mine ventilation installations, 2:55704

COAL MINES/BOREHOLES
Determination of the optimum depression in methane-drainage boreholes in mines (2 refs), 2:55696

COAL MINES/COAL DEPOSITS
Poland's coal and lignite mining programme will ensure its future energy requirements, 2:55678

COAL MINES/COAL INDUSTRY
Poland's coal and lignite mining programme will ensure its future energy requirements, 2:55678

COAL MINES/COMMUNICATIONS
Coal mining electrical and electronic engineering, 2:55681

COAL MINES/CONTROL EQUIPMENT
Coal mining electrical and electronic engineering, 2:55681

COAL MINES/CONTROL SYSTEMS
Geamatic 2000 I, a new automation system for underground mining installations, 2:55705

COAL MINES/ELECTRIC CABLES
Coal mining electrical and electronic engineering, 2:55681

COAL MINES/ELECTRICAL EQUIPMENT
Geamatic 2000 I, a new automation system for underground mining installations, 2:55705

West Virginia Univ. professors work for electrical safety, 2:55677
COAL MINES/ELECTRONIC EQUIPMENT
Coal mining electrical and electronic engineering, 2:55681
COAL MINES/GEOLOGIC STRUCTURES
Study on the outburst of gas and coal: on the geological structure conditions and back effect of blasting (11 refs), 2:55690
COAL MINES/HAZARDS
Point load strength of some Indian rocks (16 refs), 2:55701
COAL MINES/HOISTS
Dismantling and installation of longwall face with powered supports (3 refs), 2:55698
COAL MINES/HYDRAULIC EQUIPMENT
Rubber pipe for hydraulic stowing, 2:55718
COAL MINES/INFORMATION SYSTEMS
Organization of data search and data representation in a coal mine information retrieval system, 2:55711
COAL MINES/LIGHTING SYSTEMS
Coal mining electrical and electronic engineering, 2:55681
COAL MINES/METHANE
Determination of the optimum depression in methane-drainage boreholes in mines (2 refs), 2:55696
COAL MINES/MINING EQUIPMENT
Roadway drivages and drilling in coal mines, 2:55685
COAL MINES/POLAND
Poland's coal and lignite mining programme will ensure its future energy requirements, 2:55678
COAL MINES/PRODUCTION
Some problems of formalization of the process of introduction of research results into production, 2:55710
COAL MINES/PRODUCTIVITY
Coal mining electrical and electronic engineering, 2:55681
Ranging-arm shearer: its introduction in the Barnsley seam at Frickley Colliery, 2:55686
COAL MINES/ROCK BURSTS
Bearing pressure as a factor reducing seam burst hazards, 2:55738
Role of porous and fissiparous structure of coal in creating burst hazard situations and in mechanisms of sudden coal and gas bursts, 2:55737
Study on the outburst of gas and coal: on the geological structure conditions and back effect of blasting (11 refs), 2:55690
Sudden coal and gas bursts. ways to solve the problem (11 refs), 2:55736
COAL MINES/ROCK MECHANICS
Bearing pressure as a factor reducing seam burst hazards, 2:55738
Point load strength of some Indian rocks (16 refs), 2:55701
Role of porous and fissiparous structure of coal in creating burst hazard situations and in mechanisms of sudden coal and gas bursts, 2:55737
COAL MINES/ROOF BOLTS
Dismantling and installation of longwall face with powered supports (3 refs), 2:55698
Improvement of designs of sets for preparatory workings in Moscow basin conditions, 2:55702
COAL MINES/SAFETY
West Virginia Univ. professors work for electrical safety, 2:55677
COAL MINES/SAFETY ENGINEERING
Coal mining electrical and electronic engineering, 2:55681
COAL MINES/STRESSES
Control of stress distribution around mine workings, 2:55708
COAL MINES/STRUCTURAL MODELS
Model studies of mine roadway deformation, 2:55679
COAL MINES/SUBSURFACE STRUCTURES
Shield support practice in German coal mining (5 refs), 2:55691
COAL MINES/SUPPORTS
Shield support practice in German coal mining (5 refs), 2:55691
COAL MINES/TRANSPORTATION SYSTEMS
Expediency of using monorail suspended railroads with locomotive traction, 2:55709
Integrated method of determination of optimal reliability indices of the transportation and technological network of a coal mine, 2:55707
Principal tasks and lines of development in higher educational establishments of studies concerning transportation in coal mines in the tenth five-year plan period, 2:55721
Roadway drivages and drilling in coal mines, 2:55685
Trolley-wire-operated underground locomotive with manual and remote control, including fully automatic control and speed regulation, 2:55706
COAL MINES/TUNNELS
Experimental study on roadway swelling in coal mines--1. Effect of roadway depth on swelling (6 refs), 2:55668
Model studies of mine roadway deformation, 2:55679
Roadway drivages and drilling in coal mines, 2:55685
COAL MINES/UNDERGROUND MINING
Installation of the Anderson Strathclyde buttock shearer North Yorkshire area, 2:55682
COAL MINES/VENTILATION
Modern mine ventilation installations, 2:55704
Some practical experiences using sulphur hexafluoride as a tracer gas to determine leakage rates in mine ventilation systems, mainly in the South Nottinghamshire area, 2:55680
COAL MINES/WASTE WATER
Feasibility of using electrochemical coagulation to purify mine water (9 refs), 2:55653
COAL MINES/WORKING CONDITIONS
Ranging-arm shearer: its introduction in the Barnsley seam at Frickley Colliery, 2:55686
COAL MINING
See also LONGWALL MINING
SURFACE MINING
UNDERGROUND MINING
Report on coal. Status report of the Ad Hoc Committee on Energy Resources and Technology of the Atomic Industrial Forum, March 1975 (26 refs), 2:55658 (NP-22116)
COAL MINING/DRILLS
Evaluation of wet-head drilling techniques. Open file report, 2:55672 (PB-264997)
COAL MINING/ECONOMIC IMPACT
State taxation of mineral deposits and production. Final report (Western states), 2:56956 (PB-264575)
COAL MINING/ENVIRONMENTAL EFFECTS
Social and environmental assessment of coal and uranium in the Western United States, 2:55939
COAL MINING/GROUND SUBSIDENCE
Subsidence of packing rocks under pressure, 2:55693
COAL MINING/INFORMATION RETRIEVAL
Terminology and classification of qualitative characteristics of coal mines, 2:55697
COAL MINING/MINING EQUIPMENT
Brown coal: open pit technique reaches new order of magnitude, 2:55683
Feed system of a coal getting combine (Patent; 11 claims), 2:55670
Foreseeable developments of mining techniques in large coal-producing countries, 2:55687
Selection of the shape of cross-section of mine workings driven by combines, 2:55692
Spill-plate apparatus for a mining machine (Patent; 14 claims), 2:55675
COAL MINING/REVIEWS
Mining engineering's annual review of coal and industrial minerals. I, 2:55684
COAL MINING/SAFETY
Plugging techniques that should allow mining through wells. Final report, 2:55779 (MERC/RI-77/1)
COAL MINING/SOCIAL IMPACT
State taxation of mineral deposits and production. Final report (Western states), 2:56956 (PB-264575)
COAL MINING/SOCIO-ECONOMIC FACTORS
Coal development information packet. Supplement 1, 2:55655 (NP-22076)
COAL MINING/TECHNOLOGY UTILIZATION
Foreseeable developments of mining techniques in large coal-producing countries, 2:55687
COAL PREPARATION/EQUIPMENT
Effect of support on an inclined measuring tank on the load on measuring probes of batching tank scales in a skip pit bottom, 2:55717
Statistical analysis of patents for determination of the world level of development of coal pulverization equipment at steam power plants, 2:55720
COAL PREPARATION/PATENTS
Statistical analysis of patents for determination of the world level of development of coal pulverization equipment at steam power plants, 2:55720
COAL PREPARATION/REVIEWS
Mining engineering's annual review of coal and industrial minerals. I, 2:55684
COAL PREPARATION/WASTES
Selective agglomeration in the treatment of fine coal refuse, 2:55652
COAL PREPARATION PLANTS/AIR POLLUTION CONTROL
Sulfur, moisture and ash reduction in coal preparation research (11 refs), 2:55554
COAL PREPARATION PLANTS/ENVIRONMENTAL EFFECTS
Sulfur, moisture and ash reduction in coal preparation research (11 refs), 2:55554
COAL PREPARATION PLANTS/GASEOUS WASTES
Sulfur, moisture and ash reduction in coal preparation research (11 refs), 2:55554
COAL RESERVES
Report on coal. Status report of the Ad Hoc Committee on Energy Resources and Technology of the Atomic Industrial Forum, March 1975 (26 refs), 2:55658 (NP-22116)
COAL TAR/CHEMICAL COMPOSITION
Investigation of aromatic fractions from coal tar produced by an underground coal gasification test, 2:55561 (CONF-770510-7)

COAL TAR/FRACTIONATION
Investigation of aromatic fractions from coal tar produced by an underground coal gasification test, 2:55561 (CONF-770510-7)
Properties of coal liquids produced by the Occidental flash pyrolysis process (4 refs), 2:55618 (CONF-760885-)
COAL TAR/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
COALCON PROCESS/COMMERCIALIZATION
ERDA demonstration plant program for high-Btu gas, 2:55594
COAL-DERIVED LIQUIDS
See COAL LIQUIDS
COAL-FIRED MHD GENERATORS/COMBUSTION CHAMBERS
CDIF combustor Instrumented Test Section. Final report, 2:56988 (TID-27147)
Conceptual design of a CDIF Instrumented Test Section, 2:56989 (TID-27149)
COAL-FIRED MHD GENERATORS/EXPERIMENT PLANNING
Investigation of cathode spots in the presence of slag films on open-cycle MHD-generator electrodes, 2:56995
COAL-FIRED MHD GENERATORS/SLAGS
Velocity and temperature distributions of coal-slag layers on magnetohydrodynamic generator walls, 2:56997 (N-77-16445)
COAL-FIRED MHD GENERATORS/TEST FACILITIES
CDIF combustor Instrumented Test Section. Final report, 2:56988 (TID-27147)
Conceptual design of a CDIF Instrumented Test Section, 2:56989 (TID-27149)
COASTAL WATERS/WASTE DISPOSAL
Mixing process of pollutants in coastal waters, 2:57392 (NIRS-M-10)
COASTAL WATERS/WATER POLLUTION
Fate of nuclides in natural water systems. Annual progress report, October 1, 1976-September 30, 1977 (Natural ^{234}Th and ^{210}Po tracer studies of trace metal cycling in coastal waters), 2:57353 (COO-3573-26)
COATED FUEL PARTICLES/AMOEBA EFFECT
Kernel migration for HTGR fuels from the system Th-U-Pu-C-O-N, 2:56446
COATED FUEL PARTICLES/FABRICATION
Improved gas distributor for coating HTGR fuel particles, 2:55872
Method and fluidized bed furnace for coating nuclear fuel particles and others (Patent), 2:56714
Mixing of particles in a spouted bed (Patent; HTGR), 2:56451
Preparation of fuel elements for high temperature gas cooled reactors (Patent), 2:56457
COATED FUEL PARTICLES/PERFORMANCE TESTING
Interaction of LaC_2 and NdC_2 with SiC in HTGR particles, 2:56428 (CONF-770708-5)
COATED FUEL PARTICLES/PRODUCTION
Fuel particles with coatings without property gradients (Patent), 2:55869
COATED FUEL PARTICLES/THERMAL STRESSES
Transient behavior of HTGR fuel particles, 2:56433
COATINGS
See also PROTECTIVE COATINGS
COATINGS/CHEMICAL VAPOR DEPOSITION
Method and fluidized bed furnace for coating nuclear fuel particles and others (Patent), 2:56714
COBALT 60/RADIOECOLOGICAL CONCENTRATION
Concentrations of radionuclides and selected stable elements in fruits and vegetables, 2:57381 (CONF-770676-1)
COBALT BASE ALLOYS
See also STELLITE
COBALT BASE ALLOYS/FRICTION
Evaluation of cobalt and nickel base materials for sliding and static contact applications in a liquid metal fast breeder reactor, 2:56498 (CONF-760503-P1)
COBALT BASE ALLOYS/MICROSTRUCTURE
Microstructural effects in abrasive wear. Quarter progress report, 15 March 1977-15 June 1977, 2:57104 (COO-4246-1)
COBALT BASE ALLOYS/WEAR RESISTANCE
Microstructural effects in abrasive wear. Quarter progress report, 15 March 1977-15 June 1977, 2:57104 (COO-4246-1)
COBALT COMPLEXES/NEUTRON DIFFRACTION
Neutron diffraction studies of tetrahedral cluster transition metal hydride complexes: $HFeCo_3(CO)_9(P(OCH_3)_3)_3$ and $H_3Ni_4(C_5H_5)_4$, 2:57209 (BNL-22982)
COBALT COMPLEXES/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance studies of diamagnetic metal-aminopolycarboxylate complexes, 2:57229
COED PROCESS
Catalytic hydrogenation of coal-derived liquids. Interim report, March 1977-May 1977, 2:55556 (FE-2034-7)
COED PROCESS/FLOWSHEETS
Engineering evaluations of coal conversion processes. Part I. Hydrocarbonization and Synthoil: information base, process selection, and preliminary evaluation of alternatives, 2:55617 (ORNL/TM-5034)
COFFEE
See BEVERAGES
CO-GENERATION
European waste-to-energy systems. Case study of Munich: Munich North IA and IB, Munich North II, Munich South IV and V, 2:56981 (CONS/2103-4)
Power industry in the first year of the tenth five-year plan period and the tasks for 1977, 2:56979
COKE/COMBUSTION
Combustion of carbon. Effect of sulfur dioxide, 2:55804
COKE/PARTICLE SIZE
Effect of coke properties on blast furnace operation (4 refs), 2:55628
COKE/PELLETIZING
Agglomerated brown coal fine coke as a sintering fuel (100 refs.), 2:55644 (NP-22126)
COKE/PHYSICAL PROPERTIES
Agglomerated brown coal fine coke as a sintering fuel (100 refs.), 2:55644 (NP-22126)
COKE/PRODUCTION
Hydrocarbonization process evaluation report. Volume II. Evaluation of process feasibility (49 refs), 2:55558 (ORNL-5213)
COKE OVENS/ELECTRICAL EQUIPMENT
Automation of coking plant servicing machines, 2:55551
COKING/BY-PRODUCTS
Future of the coal byproducts industry, 2:55589
COKING/GLOBAL ASPECTS
Coke production: metallurgical coke, foundry coke, molded coke, 2:55550
COLD LAKE DEPOSIT/LITHOLOGY
Importance of reservoir description in evaluating in-situ recovery methods for Cold Lake heavy oil. I. Reservoir description, 2:55842
Importance of reservoir description in evaluatiang in-situ recovery methods for Cold Lake heavy oil. II. In-situ application, 2:55841
COLD LAKE DEPOSIT/STRATIGRAPHY
Importance of reservoir description in evaluating in-situ recovery methods for Cold Lake heavy oil. I. Reservoir description, 2:55842
Importance of reservoir description in evaluatiang in-situ recovery methods for Cold Lake heavy oil. II. In-situ application, 2:55841
COLD TRAPS/OPERATION
Improved method for operating sodium system cold traps, 2:56543
COLLIERIES
See COAL MINES
COLLISIONS
See also ATOM-ATOM COLLISIONS
ATOM-MOLECULE COLLISIONS
ELECTRON-ATOM COLLISIONS
ELECTRON-ION COLLISIONS
ELECTRON-MOLECULE COLLISIONS
ION-ATOM COLLISIONS
ION-MOLECULE COLLISIONS
MOLECULE-MOLECULE COLLISIONS
POSITRON COLLISIONS
COLLISIONS/MEETINGS
Physics of electronic and atomic collisions, 2:57517
COLLISIONS/VARIATIONAL METHODS
Variational principles, subsidiary extremum principles, and variational bounds (Review), 2:57548
COLLOIDS/SORPTIVE PROPERTIES
Adsorption of metal ions on colloidal silica, 2:56210
COLMONOY/FRICTION
Friction and wear behavior of Colmonoy and Stellite alloys in sodium environment, 2:56496 (CONF-760503-P1)
COLMONOY/WEAR
Friction and wear behavior of Colmonoy and Stellite alloys in sodium environment, 2:56496 (CONF-760503-P1)
COLOR MODEL/NEUTRAL CURRENTS
Weak interaction of colored hadrons, 2:57576
COLORADO/HEAT FLOW
Terrestrial heat flow along the Rio Grande rift, New Mexico and southern Colorado, 2:56177 (PB-265038)
COLORADO/OIL SHALE INDUSTRY
Oil shale development in northwestern Colorado: water and related land impacts. Water resources management workshop, 2:55851 (IES-48)
COLUMBIUM
See NIOBIUM
COMBINED-CYCLE POWER PLANTS/DESIGN
Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant. Phase II. Quarterly

technical progress report, April-June 1977, 2:55568 (FE-1521-51)
Layout of a scheme of combined diesel engine and turbine plants, 2:56246
COMBINED-CYCLE POWER PLANTS/FEASIBILITY STUDIES
Underground coal gasification (13 refs), 2:55588
COMBINED-CYCLE POWER PLANTS/GAS TURBINES
High temperature turbine technology program. Phase I. Program and system definition. Topical report: fuels cleanup and turbine tolerance, 2:56245 (FE-2290-27)
Thermal tests of a GT-35 gas turbine unit operating in a steam and gas turbine power plant with a high-pressure boiler, 2:56288
COMBINED-CYCLE POWER PLANTS/PLANNING
Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant. Phase II. Quarterly technical progress report, April-June 1977, 2:55568 (FE-1521-51)
COMBUSTION/MATHEMATICAL MODELS
Computational simulation of shock-induced gas-phase reactions, 2:57247
COMBUSTION CHAMBERS
See also COMBUSTORS
COMBUSTION CHAMBERS/CORROSION PROTECTION
Some questions of high-temperature vanadic corrosion and principal lines of development of heat-resistant materials, 2:57137
COMBUSTION CHAMBERS/DESIGN
Exhaust gas emissions of Brown Boveri gas turbines, 2:56347
Results of investigation of a new combustion chamber, 2:57021
COMBUSTION CHAMBERS/EFFICIENCY
Preparation of liquid fuels by gas atomization, 2:57317
COMBUSTION CHAMBERS/MECHANICAL VIBRATIONS
Experimental investigation of vibration regimes of combustion in combustion chambers of the U-25 plant, 2:56994
COMBUSTION CHAMBERS/TEST FACILITIES
CDIF combustor Instrumented Test Section. Final report, 2:56988 (TID-27147)
Conceptual design of a CDIF Instrumented Test Section, 2:56989 (TID-27149)
COMBUSTION ENGINEERING STANDARD REACTOR
See CE STANDARD REACTOR
COMBUSTORS
See also BURNERS
COMBUSTION CHAMBERS
COMBUSTORS/DESIGN
European waste-to-energy systems. An overview, 2:57022 (CONS/2103-6)
COMMERCIAL BUILDINGS/ENERGY CONSUMPTION
Report from Berkeley (Summary of 1975 summer study at LBL on Efficient Use of Energy in Buildings), 2:56946
COMMON MARKET/ENERGY POLICY
Present coal and energy policy in the European community, 2:55739
COMMUNITIES/LAND USE
Land use-energy simulation model: a computer-based model for exploring land use and energy relationships, 2:56915 (BNL-50634)
COMMUNITIES/RECYCLING
Recycling waste (Book), 2:56925
COMMUNITIES (ECOLOGICAL)
See ECOSYSTEMS
COMPATIBILITY (IMMUNOLOGICAL)
See IMMUNITY
COMPONENT COOLING SYSTEMS
See AUXILIARY WATER SYSTEMS
COMPOSITE MATERIALS/ELECTRICAL PROPERTIES
Advanced composites: electromagnetic properties, vulnerabilities, and protective measures, 2:57167 (R-1979-AF)
COMPOSITE MATERIALS/MAGNETIC PROPERTIES
Advanced composites: electromagnetic properties, vulnerabilities, and protective measures, 2:57167 (R-1979-AF)
COMPOSITE MATERIALS/OPTICAL PROPERTIES
Effective medium theory of optical properties of small particle composites, 2:57169
COMPOSITE MATERIALS/PERFORMANCE TESTING
Lifetimes of fiber composites under sustained tensile loading, 2:57252 (UCRL-78367)
COMPOSITE MATERIALS/SERVICE LIFE
Lifetimes of fiber composites under sustained tensile loading, 2:57252 (UCRL-78367)
COMPOSITE MATERIALS/ULTRASONIC TESTING
Ultrasonic data acquisition, analysis, and display by minicomputer aided techniques, 2:57308 (SAND-77-0526C)
COMPOUND PARABOLIC CONCENTRATORS
See also PARABOLIC REFLECTORS
Use of solid-dielectric compound parabolic concentrators with photovoltaic devices, 2:56074
COMPOUNDS (ORGANIC)
See ORGANIC COMPOUNDS
COMPRESSED AIR ENERGY STORAGE
Brown Boveri air-storage gas turbines, 2:56261
COMPRESSED AIR ENERGY STORAGE/FEASIBILITY STUDIES
Preliminary feasibility evalution of compressed air storage power systems. Volume II. Appendices, period June 1975-December 1976, 2:56884 (CONS/NSF/42-1)
COMPRESSED AIR ENERGY STORAGE/UNDERGROUND STORAGE
Preliminary feasibility evalution of compressed air storage power systems. Volume II. Appendices, period June 1975-December 1976, 2:56884 (CONS/NSF/42-1)
COMPRESSORS
See also GAS COMPRESSORS
TURBOMACHINERY
COMPRESSORS/DESIGN
Development of brown boveri gas turbine compressors, 2:56264
COMPRESSORS/SURGES
Investigation of surge protection of compressors of gas turbine power plants, 2:56335
COMPUTER CALCULATIONS/ALGORITHMS
Relationship between the BFGS and conjugate gradient algorithms, 2:57806 (ANL-AMD-TM-282(Rev.))
COMPUTER CALCULATIONS/EFFICIENCY
Matching machines and problems (Enhancement of computational efficiency), 2:57823 (UCRL-79287)
COMPUTER CODES
A directory of computer software applications: energy. Report for 1974-1976, 2:56909 (PB-264200)
EBT time-dependent point model code: description and user's guide, 2:57628 (ORNL/CSD/TM-27)
Users guide to finger, thumb, and triple axis real time experiment control programs (Neutron scattering spectrometer), 2:57335 (IS-4169)
COMPUTER CODES/BIBLIOGRAPHIES
Bibliography on available computer programs in the general area of heating, refrigerating, air conditioning and ventilating. Research project, 2:57004 (PB-264904)
COMPUTER CODES/C CODES
Decision-table development for use with the CAT code for the automated fault-tree construction, 2:56790 (PB-265098)
Some subroutines for producing captioned contour line plots and line graphs on film (CONTUR, DECIDE, SECDRV, CRVTRC, EQUPOT, in FORTRAN for IBM 360), 2:57805 (ANL-AMD-TM-191)
COMPUTER CODES/D CODES
DEROCS: a computer program to simulate offshore oil and natural gas development scenarios and onshore service base requirements, 2:55757 (USGS-OFR-77-130)
DKR: a radioactivity calculation code and decay chain data library, 2:57792
Installation of DSS/2 on the IBM 360/195 computer at K-25 (Implementation of CDC 6400 code on IBM computer, considers precision problems due to small word length), 2:57810 (K/CSD/TM-14)
Some subroutines for producing captioned contour line plots and line graphs on film (CONTUR, DECIDE, SECDRV, CRVTRC, EQUPOT, in FORTRAN for IBM 360), 2:57805 (ANL-AMD-TM-191)
COMPUTER CODES/E CODES
ELIPTI code: Part I (For solving nonlinear elliptic problems over 2D regions of arbitrary shape), 2:57826 (UCRL-79328(Pt.1))
Some subroutines for producing captioned contour line plots and line graphs on film (CONTUR, DECIDE, SECDRV, CRVTRC, EQUPOT, in FORTRAN for IBM 360), 2:57805 (ANL-AMD-TM-191)
COMPUTER CODES/F CODES
FORMS: a generator of time-card forms, 2:57817 (UCID-30151)
FRAP-S2: a computer code for the steady state analysis of oxide fuel rods, 2:56369 (TREE-NUREG-1107)
COMPUTER CODES/G CODES
Calculation of nonstationary gas network using the Ganesi program system, 2:55821
Nonstationary gas network calculation: simulation and comparative measurement, 2:55822
COMPUTER CODES/H CODES
HYDY-B1 CODE: calculational model for core thermo-hydraulics during a loss-of-coolant accident, 2:56782 (JAERI-M-6539)
Implementation of the large mathematical model HEMP on the STAR-100 computers, 2:57822 (UCRL-52277)
COMPUTER CODES/I CODES
INGEN: a general purpose mesh generator for finite element codes, 2:57812 (LA-UR-77-1345)
COMPUTER CODES/K CODES
K-FIX: a computer program for transient, two-dimensional, two-fluid flow, 2:56785 (LA-NUREG-6623)

Simplified method of computing clad and fuel strain and stress during irradiation (KRESS code), 2:56560
COMPUTER CODES/M CODES
MANAGER: a generator of reports on the expenditure of scientific manpower, 2:57818 (UCID-30152)
MODSAP: a modified version of the program SAP IV for the static and dynamic response of linear and localized nonlinear structures, 2:57808 (GA-A-14405)
COMPUTER CODES/N CODES
Nuclear inventory and management system (NIMS): a program for nuclear fuels accounting, 2:56605
COMPUTER CODES/O CODES
ORSLAP: a digital computer program for dynamic simulation of a multinode sodium loop during transients, 2:56788 (ORNL/TM-5322)
COMPUTER CODES/P CODES
PURSE: plutonium radiation source code (CDC-6600), 2:55868 (PNCT-841-75-37)
COMPUTER CODES/R CODES
Data input manual for RSI/TRANCO: a finite element heat conduction computer program, 2:57475 (Y/OWI/SUB-77/22303/1)
COMPUTER CODES/S CODES
Computational solution of nonlinear two-point boundary-value problems (SUPOR Q, in FORTRAN for CDC 6600), 2:57814 (SAND-76-5572)
Equating degrees of freedom in the SAP finite element code, 2:57809 (K/CSD/TM-13)
SOLCOST: solar hot water handbook. A simplified design method for sizing and costing residential and commercial solar service hot water systems, 2:56111 (DSE/2531-2)
Some subroutines for producing captioned contour line plots and line graphs on film (CONTUR, DECIDE, SECDRV, CRVTRC, EQUPOT, in FORTRAN for IBM 360), 2:57805 (ANL-AMD-TM-191)
COMPUTER CODES/T CODES
THECA: a code system for 3-D thermohydraulic layout of fast reactors (LMFBR), 2:56537 (EURFNR-1437)
COMPUTER GRAPHICS/COMPUTER CODES
Some subroutines for producing captioned contour line plots and line graphs on film, 2:57805 (ANL-AMD-TM-191)
COMPUTER PROGRAMMING
See PROGRAMMING
COMPUTER-AIDED DESIGN
Graph model of behavior simulator (Interactive simulator developed as part of UCLA SARA system), 2:57821 (UCLA-34P214-42)
State of the implementation of SARA (Structured design procedure), 2:57820 (UCLA-34P214-40)
COMPUTER-AIDED DESIGN/PROGRAMMING
Software engineering techniques in design automation: a tutorial, 2:57827 (UCRL-79426)
COMPUTERS
See also CDC COMPUTERS
DIGITAL COMPUTERS
PDP COMPUTERS
COMPUTERS/EQUIPMENT INTERFACES
Emmy/Unibus interface design specification. Technical note No. 109, 2:57815 (SU-326-P.39-19)
COMPUTERS/IMAGE PROCESSING
Role of midi-maxi computer interaction in nuclear medicine, 2:57423
COMPUTERS/MATHEMATICAL MODELS
Universally faithful transformations for ergodic machines, 2:57824 (UCRL-79308)
CONCENTRATING COLLECTORS/SOLAR REFLECTORS
Prisms with total internal reflection as solar reflectors, 2:56147
CONCRETES
See also REINFORCED CONCRETE
CONCRETES/HARDENING
Study of a method of accelerated hardening of concrete by microwaves, 2:57165 (ORNL-tr-4356)
CONCRETES/LATENT HEAT STORAGE
Thermocrete heat storage materials: applications and performance specifications, 2:56167
CONDENSATES/EVAPORATION
Recovery of retrograde condensed liquids by revaporization during dry gas injection, 2:55815
CONDENSATES/RECOVERY
Recovery of retrograde condensed liquids by revaporization during dry gas injection, 2:55815
CONDENSED AROMATICS
See also BENZOPYRENE
CONDENSED AROMATICS/THERMODYNAMIC PROPERTIES
Thermochemistry and kinetics of coal conversion, 2:55634 (CONF-760885-)
CONNECTICUT/AIR QUALITY
Technical support to the state of Connecticut in development of an air quality maintenance plan. Final report, 2:57356 (PB-264362)
CONNECTICUT RIVER/WATER RESOURCES
Significant interrelationships between electric power generation and natural and developed resources in the Connecticut River Basin, 2:56012 (PB-264753)
CONSERVATION (RESOURCE)
See RESOURCE CONSERVATION
CONTAINERS
See also CALANDRIAS
CASKS
DEWARS
HOPPERS
PRESSURE VESSELS
TANKS
Elastic solutions for selected circular-symmetric problems as applied to the design of the waste-container sleeve. Technical memorandum report RSI-0007, 2:55909 (ORNL/SUB-3706/4)
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Thermoelastic/plastic analysis of waste-container sleeve: III. Influence of salt strength on sleeve loading. Technical memorandum report (RSI-0018), 2:55911 (ORNL/SUB-4269/2)
Thermoelastic/plastic analysis of waste-container sleeve: IV. Air gap influence on hole closure. Technical memorandum report (RSI-0019), 2:55912 (ORNL/SUB-4269/3)
CONTAINMENT SHELLS/FABRICATION
Prospects of improving pearlitic steels for reactor shells and other equipment of the first loop of nuclear power plants, 2:56694
CONTAINMENT SHELLS/STRESS ANALYSIS
Stress analysis of partial sphere used for bottom shell of off-shore structure, 2:56691
CONTAINMENT SHELLS/WELDED JOINTS
Fracture toughness of welded joints of ASTM A543 steel plate, 2:56674
CONTAINMENT SYSTEMS/DESIGN
Nuclear reactor with a containment and reactor pressure vessel and a pressure suppression vessel arranged in the containment (Patent; BWR), 2:56393
CONTAINMENT SYSTEMS/PRESSURE SUPPRESSION
Reactor containment analysis for BWR suppression systems. Progress report for January-March 1977, 2:56795 (UCRL-50045-77-1)
CONTINENTAL SHELF/ELECTRICAL SURVEYS
Drilling/exploration activities, 2:57464
CONTINENTAL SHELF/GEOCHEMICAL SURVEYS
Drilling/exploration activities, 2:57464
CONTINENTAL SHELF/LEASING
Local regulation of pipeline sitings and the doctrines of Federal preemption and supremacy, 2:56958 (PB-265447)
CONTINENTAL SHELF/PETROLEUM DEPOSITS
Drilling/exploration activities, 2:57464
CONTROL ELEMENTS
See also SCRAM RODS
CONTROL ELEMENTS/DESIGN
Absorber rod to control a nuclear reactor with a charge of spherical fuel elements (Patent; Pebble Bed Reactors), 2:56732
Industrial technique (Patent), 2:56711
CONTROL EQUIPMENT
See also FLOW REGULATORS
SPEED REGULATORS
CONTROL EQUIPMENT/RELIABILITY
Improving the reliability of automatic calculation of technical and economic performance indices by the automatic error correction method, 2:56292
CONTROL RODS
See CONTROL ELEMENTS
CONTROL SYSTEMS
(For automated processes including feedback.)
See also ELECTRONIC GUIDANCE
ON-LINE CONTROL SYSTEMS
REACTOR CONTROL SYSTEMS
CONTROL SYSTEMS/ECONOMICS
Determination of the annual economic effect of automation of control of an electric utility enterprise, 2:56921
CONTROL THEORY (REACTOR)
See REACTOR KINETICS
CONVECTIVE INSTABILITIES/INSTABILITY GROWTH RATES
Influence of strong inhomogeneities on high-frequency mirror-drift-cone and convective-loss-cone instabilities, 2:57667

CONVERTERS (IMAGE)
See IMAGE CONVERTERS
CONVEYORS/DESIGN
Coal mine-coal conversion plant interface evaluation and conceptual design. Phase II. Monthly technical progress report, 1 April-30 April 1977, 2:55582 (FE-2370-13)
COOLANT CLEANUP SYSTEMS/PERFORMANCE
Experience with sodium purification on large-scale operational test loops in France (LMFBR), 2:56487 (CONF-760503-P1)
Identification of impurities in sodium and its purification (LMFBR), 2:56488 (CONF-760503-P1)
Sodium and cover gas chemistry in the high temperature sodium facility (LMFBR), 2:56489 (CONF-760503-P1)
COOLANT LOOPS
See also REACTOR COOLING SYSTEMS
COOLANT LOOPS/METALLURGY
Metallurgical problems associated with large sodium loop operations, 2:56485 (CONF-760503-P1)
COOLERS
See HEAT EXCHANGERS
COOLING PONDS/COMPARATIVE EVALUATIONS
Overview of economic, legal, and water availability factors affecting the demand for dry and wet/dry cooling for thermal power plants, 2:56237 (BNWL-2268)
COOLING PONDS/ECONOMICS
Overview of economic, legal, and water availability factors affecting the demand for dry and wet/dry cooling for thermal power plants, 2:56237 (BNWL-2268)
COOLING PONDS/LEGAL ASPECTS
Overview of economic, legal, and water availability factors affecting the demand for dry and wet/dry cooling for thermal power plants, 2:56237 (BNWL-2268)
COOLING PONDS/WATER RESOURCES
Overview of economic, legal, and water availability factors affecting the demand for dry and wet/dry cooling for thermal power plants, 2:56237 (BNWL-2268)
COOLING SYSTEM (REACTOR)
See REACTOR COOLING SYSTEMS
COOLING SYSTEMS
See also COOLANT LOOPS
REACTOR COOLING SYSTEMS
COOLING SYSTEMS/ENVIRONMENTAL EFFECTS
Report of a workshop on the impact of thermal power plant cooling systems on aquatic environments, Asilomar, Pacific Grove, California, September 28-October 2, 1975. Volume I. Working group results, 2:57401 (EPRI-SR-38(Vol.1))
COOLING TOWERS
See also NATURAL DRAFT COOLING TOWERS
COOLING TOWERS/BUILDING MATERIALS
Aluminum as construction material for cooling towers, 2:56456
COOLING TOWERS/COMPARATIVE EVALUATIONS
Overview of economic, legal, and water availability factors affecting the demand for dry and wet/dry cooling for thermal power plants, 2:56237 (BNWL-2268)
Study of the comparative costs of five wet/dry cooling tower concepts, 2:56236 (BNWL-2122)
COOLING TOWERS/COST
Engineering and cost comparison of three different all-dry cooling systems, 2:56241
Study of the comparative costs of five wet/dry cooling tower concepts, 2:56236 (BNWL-2122)
COOLING TOWERS/DESIGN
New designs in currently marketed cooling towers, 2:56238
COOLING TOWERS/ECONOMICS
Overview of economic, legal, and water availability factors affecting the demand for dry and wet/dry cooling for thermal power plants, 2:56237 (BNWL-2268)
COOLING TOWERS/ENVIRONMENTAL IMPACTS
Atmospheric impacts of wet cooling systems for power plants, 2:56752
EPRI Research Program in cooling tower technology and environmental impacts, 2:56239
Evaluation of alternative dry/wet cooling concepts for power stations, 2:56345
COOLING TOWERS/HEAT TRANSFER
Design study of cooling tower drift eliminators, 2:56240
COOLING TOWERS/LEGAL ASPECTS
Overview of economic, legal, and water availability factors affecting the demand for dry and wet/dry cooling for thermal power plants, 2:56237 (BNWL-2268)
COOLING TOWERS/PERFORMANCE
Engineering and cost comparison of three different all-dry cooling systems, 2:56241
COOLING TOWERS/TECHNOLOGY ASSESSMENT
EPRI Research Program in cooling tower technology and environmental impacts, 2:56239
COOLING TOWERS/VAPOR CONDENSATION
Design study of cooling tower drift eliminators, 2:56240
COOLING TOWERS/WATER RESOURCES
Overview of economic, legal, and water availability factors affecting the demand for dry and wet/dry cooling for thermal power plants, 2:56237 (BNWL-2268)
COOLING TOWERS/WATER TREATMENT
Cooling tower feedwater treatment for nuclear power plants, 2:56663
COPPER/BIOCHEMISTRY
Uptake of cadmium into the haemolymph of the shore crab Carcinus maenas: the relationship with copper and other divalent cations, 2:57450
COPPER/BIOLOGICAL ACCUMULATION
Copper granules in the barnacle Balanus balanoides, 2:57452
COPPER/ECOLOGICAL CONCENTRATION
Fate of nuclides in natural water systems. Annual progress report, October 1, 1976-September 30, 1977 (Natural ^{234}Th and ^{210}Po tracer studies of trace metal cycling in coastal waters), 2:57353 (COO-3573-26)
COPPER/ENVIRONMENTAL TRANSPORT
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)
Impact and fate on aquatic environments of copper from nuclear power plants, 2:57446
COPPER/ION COLLISIONS
Model of secondary electron yields from atomic and polyatomic ion impacts on copper and tungsten surfaces based upon stopping-power calculations, 2:57495
COPPER/X-RAY FLUORESCENCE ANALYSIS
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57198 (LA-6869-MS)
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57197 (LA-6869)
COPPER 63 TARGET/PROTON REACTIONS
Results of the search for the intermediate W boson in proton-nucleus collisions at 70 GeV, 2:57565
COPPER 65 TARGET/KRYPTON 86 REACTIONS
Fusion in Kr-bombardments of medium-mass nuclei, 2:57597 (CONF-770115-1)
COPPER ALLOYS
See also COPPER BASE ALLOYS
MONEL
COPPER ALLOYS/LATENT HEAT STORAGE
Thermal storage in metals, 2:56160
COPPER ALLOYS/THERMODYNAMIC PROPERTIES
Thermal storage in metals, 2:56160
COPPER BASE ALLOYS
See also BRONZE
COPPER BASE ALLOYS/SPIN-LATTICE RELAXATION
Transmission electron spin resonance in dilute CuFe alloys, 2:57103 (COO-3150-39)
COPPER COMPOUNDS/CATALYTIC EFFECTS
Molding of a low-temperature catalyst for methanol synthesis, 2:55995
COPPER ORES/RESERVES
Canadian reserves of seven metals, 2:56933
CORE FLOODING SYSTEMS/MATHEMATICAL MODELS
Reflood simulation study of the FLECHT-SET system using RELAP4/MOD6, 2:56810
Self-initialization of the RELAP4 momentum equation, 2:56811
CORE FLOODING SYSTEMS/PERFORMANCE
Effect of superheated walls on plenum filling at 1/15 scale. Quarterly progress report, October 1, 1976-December 31, 1976, 2:56773 (CREARE-TN-255)
CORIUM/HEAT TRANSFER
Natural convection in porous media with heat generation (LMFBR), 2:56801
CORROSION
See also SCALING
CORROSION/MATHEMATICAL MODELS
Corrosion of steels in liquid sodium (LMFBR), 2:56525 (CONF-760503-P1)
CORROSION PRODUCTS/CHEMICAL COMPOSITION
Geothermal power plants and their material trends, 2:56202
COSMOCHEMISTRY
Interstellar molecule formation (Kinetics), 2:57487
COSMOLOGICAL MODELS/PAIR PRODUCTION
Energy and pressure of fermion pairs created near the Friedmann singularity, 2:57488
COULOMETRY
See VOLTAMETRY
COUNTERS (RADIATION)
See RADIATION DETECTORS
CRABS
See CRUSTACEANS
CRBR REACTOR
See CLINCH RIVER BREEDER REACTOR
C-REACTIVE PROTEIN
See IMMUNITY

CREEKS
See RIVERS
CRG PROCESSES/TECHNOLOGY ASSESSMENT
Success at Westfield, 2:55587
CRITICAL ASSEMBLIES
See ZERO POWER REACTORS
CRITICAL HEAT FLUX
Critical heat flux: a review of recent publications, 2:56639
CRUDE OIL
See PETROLEUM
CRUSTACEANS/CONTAMINATION
Copper granules in the barnacle Balanus balanoides, 2:57452
CRYOGENICS/TEMPERATURE MEASUREMENT
Cryogenic instrumentation needs in the controlled thermonuclear research program, 2:57738
CRYOPUMPS/PERFORMANCE
Cryopumping of deuterium hydrogen and helium mixtures on smooth 4.2 K surfaces, 2:57785 (BNL-22759)
Cryosorption pumping of helium at 4.2 K by Type 5A molecular sieve, 2:57797
CRYOPUMPS/PERFORMANCE TESTING
Cryopump, neutral-beam compatibility test, 2:57798
CRYSTAL LATTICES/CRACKS
Segregation induced embrittlement of grain interfaces, 2:57111 (COO-3084-52)
CRYSTAL LATTICES/MATHEMATICAL MODELS
Segregation induced embrittlement of grain interfaces, 2:57111 (COO-3084-52)
CRYSTAL LATTICES/SHOCK WAVES
Theoretical studies of soliton-like behavior of shocks in one-dimensional systems, 2:57623 (UCRL-79259)
CRYSTALLINE LENS/BIOCHEMISTRY
Biochemical studies on the ocular lens in relation to cataractogenesis. Progress report, July 1, 1975-May 31, 1977 (X radiation), 2:57434 (COO-2012-27)
CSF PROCESS
Conceptual design for advanced coal liquefaction commercial plant. Quarterly technical progress report, August 1-October 31, 1976, 2:55612 (FE-2251-14)
CURIUM 244/FISSION YIELD
Actinide fission rate measurements in Zebra, 2:56474 (AEEW-R-1090)
CURIUM 248 TARGET/CALCIUM 48 REACTIONS
Search for superheavy elements in the bombardment of ^{248}Cm with ^{48}Ca, 2:57601
CURRENT LIMITERS
See also POWER TRANSMISSION LINES
CURRENT LIMITERS/DESIGN
Current limiting fuse study. Final report, 2:56349 (EPRI-EL-453(6-77))
CURRENT LIMITERS/PERFORMANCE
Current limiting fuse study. Final report, 2:56349 (EPRI-EL-453(6-77))
CUTTER LOADERS/EVALUATION
Installation of the Anderson Strathclyde buttock shearer North Yorkshire area, 2:55682
CUTTER LOADERS/INSTALLATION
Installation of the Anderson Strathclyde buttock shearer North Yorkshire area, 2:55682
CYANOGEN/OXIDATION
Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, 11 September-10 December 1976 (5 refs), 2:55723 (FE-2018-6)
CYCLOHEXIMIDE/BIOLOGICAL EFFECTS
Nitrate uptake by dark-grown corn seedlings. Some characteristics of apparent induction, 2:57419
CYCLONE SEPARATORS/PERFORMANCE TESTING
Tests and aerodynamic probing of TSP2 cyclones with a louvered swirler, 2:55719
CYCLOTRON INSTABILITY/MAGNETOACOUSTIC WAVES
Thermonuclear cyclotron magnetosonic instability of plasma, 2:57673
CYLINDERS/WEAR
Evaluation of the limit state of a cylinder and piston group of diesel engines, 2:57020
CYTOPLASM/BIOCHEMISTRY
Mechanisms of innate immunity: cytoplasmic granules of polymorphonuclear neutrophilic granulocytes, antimicrobial action, translocation, role, and fate in antimicrobial phagocytosis. Progress report, March 1976-June 30, 1977, 2:57413 (ORO-3628-11)
CZECHOSLOVAKIA/DISTRICT HEATING
District heating in the Czechoslovakian energy balance, 2:56911
CZECHOSLOVAKIA/ENERGY POLICY
District heating in the Czechoslovakian energy balance, 2:56911

D

DATA ACQUISITION/STANDARDIZATION
Standards for multilateral and world wide exchange of geothermal data, 2:56169 (LBL-6305)
DATA ACQUISITION SYSTEMS
Ultrasonic data acquisition, analysis, and display by minicomputer aided techniques, 2:57308 (SAND-77-0526C)
DAWSONITE/QUANTITATIVE CHEMICAL ANALYSIS
Quantitative determination of dawsonite in Green River shale by powder-sample x-ray diffraction: effect of grinding, 2:55848
DECAY/REVIEWS
Decaying states, 2:57619
DECAY INSTABILITY
Three-wave parametric-decay instability with arbitrary dissipation in homogeneous plasmas, 2:57669
DEEP WATER OIL TERMINALS/OPERATION
North Sea offshore loading, what is the problem, 2:55799
DEFORMATION/MEASURING INSTRUMENTS
Measurement of wave profiles in shock-loaded solids, 2:57156 (SAND-77-1056C)
DEGRADATION (NUCLEAR)
See DECAY
DEMAND LIMITERS
See CURRENT LIMITERS
DENMARK/DISTRICT HEATING
European waste-to-energy systems: case study of Koersor, Denmark, 2:56980 (CONS/2103-3)
DENMARK/MUNICIPAL WASTES
European waste-to-energy systems: case study of Koersor, Denmark, 2:56980 (CONS/2103-3)
DENSIMETERS
Density measurements in a burning cigarette (Beta radiometric gage), 2:57339
DEOXYPENTOSE NUCLEIC ACID
See DNA
DEOXYRIBONUCLEASE
See DNA-ASE
DEOXYRIBONUCLEIC ACID
See DNA
DEPRESSURIZATION/COMBUSTION
Layering and combustion in the HTGR containment following depressurization accident, 2:56803
DEPRESSURIZATION/FISSION PRODUCT RELEASE
Consequences of ultimate sequences of HTGRs, 2:56804
DESALINATION REACTORS/DESIGN
Combined system for power and desalinated water production by nuclear power stations, 2:56610
DESALINATION REACTORS/WORKING FLUIDS
Efficacy of the working media of nuclear power plants with gas-cooled fast reactors and low-temperature utilization of heat to obtain fresh water, 2:56563
DESOXYRIBONUCLEIC ACID
See DNA
DETECTORS (RADIATION)
See RADIATION DETECTORS
DETONATORS/PERFORMANCE TESTING
Empirical model to compute the velocity histories of flyers driven by electrically exploding foils, 2:57249 (LA-6809)
DEUTERIUM/BIOLOGICAL EFFECTS
Isotope chemistry and biology, 2:57438
DEUTERIUM/CHEMICAL REACTION KINETICS
Reaction between plutonium and deuterium. Part II. Rate measurements by weight changes, 2:57241 (LA-6681-MS)
DEUTERIUM/DISTILLATION
Isotope separation processes, 2:57227
DEUTERIUM/ELECTRON-MOLECULE COLLISIONS
Laser photodissociation of hydrogen molecule ions with fragment kinetic energy analysis, 2:57506
DEUTERIUM/ISOTOPE EFFECTS
Isotopic effects on the electronic properties of H_2O and D_2O in the vacuum uv, 2:57221
Use of ^{13}C and ^{1}H nuclear magnetic resonance to probe internal motion in dimethyl sulfoxide, 2:57232
DEUTERIUM/ISOTOPIC EXCHANGE
Isotope separation processes, 2:57227
DEUTERIUM/REMOVAL
Assessment of uranium and cerium as hydriding materials for hydrogen isotopes in flowing argon, 2:57799
Cryopumping of deuterium hydrogen and helium mixtures on smooth 4.2 K surfaces, 2:57785 (BNL-22759)
DEUTERIUM/VIBRATIONAL STATES
Laser photodissociation of hydrogen molecule ions with fragment kinetic energy analysis, 2:57506
DEUTERIUM IONS/ION-ATOM COLLISIONS
Dynamics of the reaction $D^+_3 + O(^3P)$ $OD^+ + D$, and the influence of the atomic quadrupole moment on the cross section at very low kinetic energies (0.002 to 27 eV), 2:57514

DEUTERIUM OXIDES
See HEAVY WATER
DEUTERON REACTIONS/ONE-NUCLEON TRANSFER REACTIONS
Reactions ^{47}Ti(d,p)^{48}Ti and ^{49}Ti(d,p)^{50}Ti at a deuteron energy 13.6 MeV (Differential cross sectios, DWBA, Hauser-Feshbach theory), 2:57595
DEUTERON REACTIONS/PARTICLE PRODUCTION
Production of ultrafast pions in collisions of relativistic deuterons with protons and nuclei, 2:57584
DEVELOPING COUNTRIES/CANDU TYPE REACTORS
Heavy water reactor best option for technology transfer, 2:56461
DEVELOPING COUNTRIES/HYDROELECTRIC POWER
Should dams be built. The Volta Lake example, 2:56013
Waterpower: a short overview, 2:56003
DEVELOPING COUNTRIES/INDUSTRIAL PLANTS
Small ammonia plants: prospects for natural-gas utilization in developing countries, 2:55810
DEWARS/DESIGN
Engineering considerations of the toroidal magnet and dewar for UWMAK. II. A Wisconsin Tokamak fusion reactor design, 2:57718
DIAMOND DRILLING EQUIPMENT
See DRILLING EQUIPMENT
DIELECTRIC MATERIALS
See also FERROELECTRIC MATERIALS
DIELECTRIC MATERIALS/ONE-DIMENSIONAL CALCULATIONS
Dielectric screening in one-dimensional disordered systems, 2:57624
DIELECTRICS
See DIELECTRIC MATERIALS
DIESEL ENGINES/AFTERBURNERS
Layout of a scheme of combined diesel engine and turbine plants, 2:56246
DIESEL ENGINES/COMBUSTION CHAMBERS
Results of investigation of a new combustion chamber, 2:57021
DIESEL ENGINES/CONTROL EQUIPMENT
Bridge control of marine diesel propulsion machinery, 2:57056
Utilization of phase-frequency characteristics in adjusting all-regime centrifugal regulators for experimental determination of their time constants, 2:57061
DIESEL ENGINES/CYLINDERS
Evaluation of the limit state of a cylinder and piston group of diesel engines, 2:57020
DIESEL ENGINES/EFFICIENCY
Relation between effective diesel engine efficiency and its output of nitrogen oxides with spent gases, 2:57059
DIESEL ENGINES/EVALUATION
Diesel engines having advantageous emission characteristics for mining plants, 2:57085
DIESEL ENGINES/EXHAUST GASES
Diesel engines having advantageous emission characteristics for mining plants, 2:57085
Relation between effective diesel engine efficiency and its output of nitrogen oxides with spent gases, 2:57059
DIESEL ENGINES/FUEL INJECTION SYSTEMS
Effect of design parameters of a fuel pump section on the injection process and the diesel engine working process, 2:57064
Mixture formation in diesel engines, 2:56991
DIESEL ENGINES/IGNITION SYSTEMS
Effect of cyclic fuel feeding on the length of the period of delay of fuel self-ignition following diesel engine start in high mountain conditions, 2:57058
DIESEL ENGINES/LUBRICATION
Investigation of the effect of the design and number of piston rings on lubricant burn-up waste, 2:57057
DIESEL ENGINES/MATHEMATICAL MODELS
Investigation of the effect of the technical condition indices of internal combustion engines on working process parameters by numerical modeling method, 2:57063
DIESEL ENGINES/PISTONS
Development of promising designs of pistons for boosted modifications of diesels of the chn21/21 type, 2:57054
Evaluation of the limit state of a cylinder and piston group of diesel engines, 2:57020
Investigation of the three-dimensional thermal and stress strained state of a one-piece piston of the chn 21/21 diesel engine, using the finite element method, 2:57324
DIESEL ENGINES/SUPERCHARGERS
Calculation of processes in the gas dynamic exchanger for diesel engine supercharging, 2:57055
Layout of a scheme of combined diesel engine and turbine plants, 2:56246
Reductions of the maximum combustion pressure of high-speed diesel engines with high supercharging, 2:57018
DIESEL ENGINES/TEST FACILITIES
Principles of setting up automated rigs to test diesel engines in conditions close to the operational ones, 2:57019
DIESEL ENGINES/THERMODYNAMICS
Method of calculation of heat transfer from a working medium to the walls of the combustion chamber of a diesel engine, 2:57328
DIESEL FUELS/CHEMICAL COMPOSITION
Correlation between the content of n-paraffins and some basic properties of diesel fuels, 2:55777
DIESEL FUELS/COMBUSTION
Effect of cyclic fuel feeding on the length of the period of delay of fuel self-ignition following diesel engine start in high mountain conditions, 2:57058
Effect of hydrocarbon groups and fractional fuel compositions on ignition and combustion processes in diesel engines, 2:57062
DIESEL FUELS/PHYSICAL PROPERTIES
Correlation between the content of n-paraffins and some basic properties of diesel fuels, 2:55777
DIFFERENTIAL EQUATIONS/NUMERICAL SOLUTION
Computational solution of nonlinear two-point boundary-value problems (SUPOR Q, in FORTRAN for CDC 6600), 2:57814 (SAND-76-5572)
ELIPTI code: Part I (For solving nonlinear elliptic problems over 2D regions of arbitrary shape), 2:57826 (UCRL-79328(Pt.1))
Installation of DSS/2 on the IBM 360/195 computer at K-25, 2:57810 (K/CSD/TM-14)
Operator splitting on vector processors (Solution of 2-D partial differential equations by method of fractional steps with application to CDC STAR), 2:57825 (UCRL-79316(Rev.1))
DIGITAL COMPUTERS/PROGRAMMING
Matching machines and problems (Enhancement of computational efficiency), 2:57823 (UCRL-79287)
DIODES (SEMICONDUCTOR)
See SEMICONDUCTOR DIODES
DIRECT CYCLE COOLING SYSTEMS
Europe pushes direct cycle development, 2:56438
DISASTERS
See ACCIDENTS
DISSOLVERS/CRITICALITY
Nuclear safety of the ten-well insert for the SRP fuel element dissolver, 2:55880 (DP-1429)
DISTRICT HEATING
District heating in the Czechoslovakian energy balance, 2:56911
Power industry in the first year of the tenth five-year plan period and the tasks for 1977, 2:56979
Results of natural-size investigations of variable conditions of operation of the low pressure section of a district heating turbine, 2:56304
Scientific and technical problems of district heating in the tenth five-year plan period, 2:57006
Simultaneous load analysis of an electricity and district-heating supply system, 2:56227
Technical development of district heating in the German Democratic Republic, 2:56342
DISTRICT HEATING/CHARGES
District heating pricing as an inducement for energy saving, 2:56912
DISTRICT HEATING/COMPUTER-AIDED DESIGN
Computer-aided hydraulic design of a ramified district heating network, 2:57010
Problems of improving the methods of design of heat supply systems, 2:57009
DISTRICT HEATING/CONSTRUCTION
Main lines of improvement of construction of district heating systems, 2:57011
DISTRICT HEATING/ECONOMICS
Economic benefits of district heating, 2:56910
Problems in heating economics and district heating, 2:56914
DISTRICT HEATING/EFFICIENCY
Economic benefits of district heating, 2:56910
Some ways to improve the efficiency of district heating in the tenth five-year plan period, 2:57007
DISTRICT HEATING/ENERGY CONSERVATION
European waste-to-energy systems. Case study of Munich: Munich North IA and IB, Munich North II, Munich South IV and V, 2:56981 (CONS/2103-4)
DISTRICT HEATING/HEAT DISTRIBUTION SYSTEMS
Principles of design of schemes of district heating systems in cities, their automation, and installation of remote control facilities, 2:56913
DISTRICT HEATING/MATHEMATICAL MODELS
Utilization of exergy function in mathematical modeling of thermal power plants, 2:56233
DISTRICT HEATING/OPERATION
Main lines of improvement of construction of district heating systems, 2:57011
DISTRICT HEATING/OPTIMIZATION
Method of calculation of the optimum coefficient of industrial district steam heating, 2:57008
DISTRICT HEATING/POWER DEMAND
Problems in heating economics and district heating, 2:56914

DISTRICT HEATING/REFUSE DERIVED FUELS
Incineration of domestic refuse: refuse into energy at Sheffield, 2:56248
DISTRICT HEATING/THERMAL EFFICIENCY
European waste-to-energy systems: case study of Koersor, Denmark, 2:56980 (CONS/2103-3)
DISTRICT HEATING/THERMAL INSULATION
Main lines of improvement of construction of district heating systems, 2:57011
DMSO
(Dimethyl sulfoxide.)
DMSO/CONFIGURATION INTERACTION
Use of ^{13}C and ^{1}H nuclear magnetic resonance to probe internal motion in dimethyl sulfoxide, 2:57232
DMSO/NUCLEAR MAGNETIC RESONANCE
Use of ^{13}C and ^{1}H nuclear magnetic resonance to probe internal motion in dimethyl sulfoxide, 2:57232
DNA
(Deoxyribonucleic acid.)
DNA/ANTIBODIES
Anti ultraviolet-irradiated DNA antibodies in xeroderma pigmentosum patients, 2:57433
DNA/BIOCHEMICAL REACTION KINETICS
Influence of Hg^{2+} on the excited states of DNA: photochemical consequences, 2:57408 (CONF-770346-1)
Studies on the repair of damaged DNA in bacteriophage, bacterial, and mammalian systems. Three year progress report (UV radiation), 2:57414 (SAN-326P32X15)
DNA/BIOCHEMISTRY
DNA replication of the parvovirus Kilham rat virus. I. Characterization of intracellular forms of viral DNA extracted by guanidine hydrochloride, 2:57410 (CONF-770555-2)
Double-helical regions in Kilham rat virus DNA, 2:57409 (CONF-770555-1)
DNA/BIOLOGICAL RADIATION EFFECTS
Anti ultraviolet-irradiated DNA antibodies in xeroderma pigmentosum patients, 2:57433
Studies on the repair of damaged DNA in bacteriophage, bacterial, and mammalian systems. Three year progress report (UV radiation), 2:57414 (SAN-326P32X15)
DNA/BIOLOGICAL REPAIR
Studies on the repair of damaged DNA in bacteriophage, bacterial, and mammalian systems. Three year progress report (UV radiation), 2:57414 (SAN-326P32X15)
DNA/EXTRACTION
DNA replication of the parvovirus Kilham rat virus. I. Characterization of intracellular forms of viral DNA extracted by guanidine hydrochloride, 2:57410 (CONF-770555-2)
DNA/HISTOLOGY
Mathematical analysis of DNA histograms from asynchronous and synchronous cell populations, 2:57417 (LA-UR-77-992)
DNA/MOLECULAR STRUCTURE
Double-helical regions in Kilham rat virus DNA, 2:57409 (CONF-770555-1)
DNA/STAINS
Flow microfluorometric and spectrophotofluorometric analysis of DNA staining in mammalian cells, 2:57416 (LA-UR-77-365)
DNA-ASE/BIOCHEMISTRY
Double-helical regions in Kilham rat virus DNA, 2:57409 (CONF-770555-1)
DOCUMENT RETRIEVAL
See INFORMATION RETRIEVAL
DOEL-1 REACTOR/COOLANT CLEANUP SYSTEMS
Reports from water practice. The condensate purification system in the nuclear power plant at Doel, 2:56423
DOEL-2 REACTOR/COOLANT CLEANUP SYSTEMS
Reports from water practice. The condensate purification system in the nuclear power plant at Doel, 2:56423
DOMESTIC ANIMALS/TEMPERATURE MEASUREMENT
Passive electronic identification and temperature monitoring system. Progress report, January-December 1976, 2:57340 (LA-6812-PR)
DOPED MATERIALS/FABRICATION
System for controlling ion implantation dosage in electronic materials (Patent), 2:57184
DOUNREAY PROTOTYPE FAST REACTOR
See PFR REACTOR
DRIFT INSTABILITY/INSTABILITY GROWTH RATES
Influence of strong inhomogeneities on high-frequency mirror-drift-cone and convective-loss-cone instabilities, 2:57667
DRIFT INSTABILITY/PERTURBATION THEORY
Initial value problem with non-Hermitian radial mode equations, 2:57665
DRILLING EQUIPMENT/DESIGN
Analysis of the custom design/fabrication/testing requirements for a large-hole drilling machine for use in an underground radioactive waste repository, 2:57329 (Y/OWI/SUB-4269/22)
DRILLING EQUIPMENT/FABRICATION
Analysis of the custom design/fabrication/testing requirements for a large-hole drilling machine for use in an underground radioactive waste repository, 2:57329 (Y/OWI/SUB-4269/22)
DRILLING EQUIPMENT/PERFORMANCE TESTING
Analysis of the custom design/fabrication/testing requirements for a large-hole drilling machine for use in an underground radioactive waste repository, 2:57329 (Y/OWI/SUB-4269/22)
DRILLING PLATFORMS
See OFFSHORE PLATFORMS
DRINKING WATER/QUALITY CONTROL
Chloro-organics in surface water sources for potable water, 2:57388 (CONF-770552-1)
DRYERS/ENERGY EFFICIENCY
Radio frequency textile drying, 2:57037
D-T REACTORS/BUILDING MATERIALS
Isotopically tailored materials for fission and fusion reactors, 2:56652 (MLM-2426(OP))
DUAL RESONANCE MODEL/PION-NUCLEON INTERACTIONS
Elastic πN scattering in a dual model with the correct spectrum of baryon resonances, 2:57581
DUAL-PURPOSE POWER PLANTS/BOILERS
Contamination of heating surfaces of boilers at Tyumen heat and power plant burning local peat, 2:56295
DUAL-PURPOSE POWER PLANTS/CONTROL SYSTEMS
Method of compiling algorithms and programs for digital computers to optimize load distribution among turbine units of heat-and-power stations, 2:56277
DUAL-PURPOSE POWER PLANTS/COOLING SYSTEMS
Noise characteristics of reducing and cooling installations, 2:56243
DUAL-PURPOSE POWER PLANTS/EFFICIENCY
Efficiency of production of heat and electric power at heat-and-power central stations, 2:56234
DUAL-PURPOSE POWER PLANTS/FUEL ECONOMY
Efficiency of production of heat and electric power at heat-and-power central stations, 2:56234
DUAL-PURPOSE POWER PLANTS/LOAD MANAGEMENT
Method of compiling algorithms and programs for digital computers to optimize load distribution among turbine units of heat-and-power stations, 2:56277
Simultaneous load analysis of an electricity and district-heating supply system, 2:56227
DUAL-PURPOSE POWER PLANTS/NOISE
Noise characteristics of reducing and cooling installations, 2:56243
DUAL-PURPOSE POWER PLANTS/OPERATION
Total energy merseyside power station extension, 2:56251
DUAL-PURPOSE POWER PLANTS/THERMODYNAMICS
Thermodynamic analysis of the work of heat-and-power turbine plants with sliding initial steam pressure, 2:56235
DUCTS/FLUID FLOW
Calculation of the motion of a medium in schematized elements of turbine ducts, 2:56331
DYE LASERS/PULSES
Ultrashort pulses from a distributed-feedback dye laser, 2:57291

E

EARS
See AUDITORY ORGANS
EARTH ATMOSPHERE
See also AIR
SURFACE AIR
EARTH ATMOSPHERE/AIR POLLUTION
Present and future production of CO_2 from fossil fuels: a global appraisal (6 refs), 2:55656 (ORAU/IEA(O)-77-15)
EARTH ATMOSPHERE/ORIGIN
Early evolution of the terrestrial atmosphere and hydrosphere, 2:57490
EARTH CRUST/HEAT FLOW
Flow of heat from the Earth's interior, 2:56206
World heat flow data collection, 1975, 2:56207
EARTH CRUST/PLATE TECTONICS
Flow of heat from the Earth's interior, 2:56206
EARTH CRUST/RADIOACTIVITY
Ratio estimation techniques in the analysis of environmental radionuclide data, 2:57379 (BNWL-SA-5975(Rev.))
EARTHQUAKES
Crustal structure and seismicity in Minnesota, 2:57472
EARTHQUAKES/FORECASTING
Evaluation of earthquake hazard in the central Mississippi Valley, 2:56744
Geologic perspectives of earthquake hazards in East-Central United States, 2:57467

Problems of seismic risk analysis in the Northeast United States, 2:57468
Relationship of seismicity to geology in the Northeastern United States, 2:57469
EARTHQUAKES/PROBABILITY
Realistic seismic safety for nuclear plants, 2:56745
E-BEAM TYPE REACTORS/THERMONUCLEAR FUELS
Electron-beam technology and electron-beam target experimental results, 2:57776
EBIS
See ELECTRON BEAM ION SOURCES
EBR-2 REACTOR/COOLANT CLEANUP SYSTEMS
On-line separation of radioiodine in highly radioactive EBR-II sodium, 2:56512 (CONF-760503-P1)
Sodium technology at EBR-II, 2:56479 (CONF-760503-P1)
EBR-2 REACTOR/FUEL CHANNELS
Clinch River Breeder Reactor Plant. Irradiated EBR-II duct crushing test and analysis, 2:56755 (CRBRP-ARD-0164)
EBR-2 REACTOR/REACTOR EXPERIMENTAL FACILITIES
Gamma heated subassembly for sodium boiling experiments, 2:56794 (TID-27639)
EBR-2 REACTOR/STEAM GENERATORS
Dynamic response of the EBR-II secondary sodium system to postulated leaks of steam and water into sodium, 2:56501 (CONF-760503-P1)
Events following postulated failures in the EBR-II steam generator system, 2:56502 (CONF-760503-P1)
ECCS
(Emergency core cooling system.)
See also CORE FLOODING SYSTEMS
ECCS/ACCUMULATORS
Bubble growth by expansion and dissolution in a variable pressure field, 2:56813
ECCS/DESIGN
Method for urgently cooling a core in high temperature gas reactor (Patent), 2:56458
ECCS/PERFORMANCE
Best-judgment analysis of emergency core cooling system performance (PWR), 2:56798
ECCS/PERFORMANCE TESTING
Semiscale Mod-1 system response during the ECC baseline test series (design of the Mod-1 baseline ECC test) (PWR), 2:56408 (TREE-NUREG-1058)
ECCS/RELIABILITY
Assessment of emergency core cooling system effectiveness for light water nuclear power reactors, 2:56881
ECCS/TEST FACILITIES
Semiscale Mod-1 system response during the ECC baseline test series (design of the Mod-1 baseline ECC test) (PWR), 2:56408 (TREE-NUREG-1058)
ECHINODERMS/CONTAMINATION
Chemical composition and effects of water extracts of petroleum on eggs of the sand dollar Melitta quinquiesperforata, 2:57448
ECOLOGICAL COMMUNITIES
See ECOSYSTEMS
ECONOMETRICS
Input-output analysis and energy intensities: a comparison of some methodologies, 2:56919
ECONOMIZERS/PERFORMANCE TESTING
Industrial tests of a membrane economizer on a TP-120 boiler at the Saratov No.2 heat-and-power plant, 2:56315
ECOSYSTEMS
See also AQUATIC ECOSYSTEMS
TERRESTRIAL ECOSYSTEMS
ECOSYSTEMS/BIOLOGICAL STRESS
Current perceptions and applicability of ecosystem analysis to impact assessment, 2:57376 (CONF-770228-1)
EDTA
(Ethylenediaminetetraacetic acid.)
EDTA/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance studies of diamagnetic metal-aminopolycarboxylate complexes, 2:57229
EDUCATION/LABORATORY EQUIPMENT
Process instrumentation measurements for nuclear engineering laboratories, 2:56615
Role of nuclear laboratory courses at Purdue University, 2:56616
EDUCATION/MEASURING INSTRUMENTS
Process instrumentation measurements for nuclear engineering laboratories, 2:56615
EFFLUENTS (CHEMICAL)
See CHEMICAL EFFLUENTS
EGYPTIAN ARAB REPUBLIC/PLANTS
Mineral element composition of the natural vegetation along a transect at Mareotis, Egypt, 2:57377
EHV AC SYSTEMS/ENVIRONMENTAL IMPACT STATEMENTS
Environmental impact analysis of Coyote Station. Volume 2 (345 kV transmission system with 115 kV connection), 2:56357 (NP-22244(Vol.2))
EINSTEIN-DE SITTER MODEL
See COSMOLOGICAL MODELS
ELECTRIC ARCS/PLASMA DIAGNOSTICS
Axial density and temperature variations in a magnetically confined arc, 2:57639
ELECTRIC BATTERIES
(Devices for production and/or storage of electrical energy from chemical reactions; excludes FUEL CELLS and RADIOISOTOPE BATTERIES.)
See also LEAD-ACID BATTERIES
ELECTRIC BATTERIES/BIBLIOGRAPHIES
Secondary aerospace batteries and battery materials: a bibliography, 1969 - 1974, 2:56888 (N-77-16437)
ELECTRIC BATTERIES/ELECTROLYTES
Lithium ion conductive electrolyte composition (Patent), 2:56902 (SAND-77-6009)
ELECTRIC BATTERIES/FABRICATION
Batteries for the '80s: the materials of energy storage, 2:56890
ELECTRIC BATTERIES/MATERIALS
Secondary aerospace batteries and battery materials: a bibliography, 1969 - 1974, 2:56888 (N-77-16437)
ELECTRIC BATTERIES/PERFORMANCE
Batteries for the '80s: the materials of energy storage, 2:56890
ELECTRIC BATTERIES/REVIEWS
Electrochemical power sources in ocean engineering, 2:56897 (AED-CONF-76-203-006)
ELECTRIC CONTACTS/FABRICATION
Analytical study of space processing of immiscible materials for superconductors and electrical contacts. Final report, 28 May 1975 - 30 Sep. 1976, 2:57092 (N-77-16075)
ELECTRIC FUSES/DESIGN
Current limiting fuse study. Final report, 2:56349 (EPRI-EL-453(6-77))
ELECTRIC FUSES/PERFORMANCE
Current limiting fuse study. Final report, 2:56349 (EPRI-EL-453(6-77))
ELECTRIC GENERATORS
(Rotating generators only; excludes DIRECT ENERGY CONVERTERS.)
See also TURBOGENERATORS
ELECTRIC GENERATORS/BUSHINGS
Problems of technology of manufacture of hydraulic generator shafts and related consequences for assembly and operation of hydraulic units, 2:56011
ELECTRIC GENERATORS/OPTIMIZATION
Computer-aided investigation of dc generators, 2:56309
ELECTRIC GENERATORS/SHAFTS
Problems of technology of manufacture of hydraulic generator shafts and related consequences for assembly and operation of hydraulic units, 2:56011
ELECTRIC MOTORS
Rectifier motor as a drive for axial pumps, 2:56693
ELECTRIC MOTORS/PERFORMANCE
Tubular axle induction motor for rail traction, 2:57067
ELECTRIC POWER
See also HYDROELECTRIC POWER
Equivalence between electricity and fuels: elements for a critical discussion, 2:56960
Impacts of the western drought on regional electricity generation. Interim report, 2:56975 (PB-265 641)
ELECTRIC POWER/AVAILABILITY
Report on the Western Energy Expansion Study, 2:56986 (NP-22295)
ELECTRIC POWER/FLOW MODELS
Energy flow patterns for 1975 (For 50 states, regions and total U.S.), 2:56982 (LA-6770)
ELECTRIC RAILWAYS
See also ELECTRIC-POWERED VEHICLES
TRAINS
ELECTRIC RAILWAYS/DESIGN
Articulated trams '2000 series' of the Zurich municipal transport authority, 2:57026
Energy saving public transport, 2:57066
ELECTRIC RAILWAYS/ELECTRIC MOTORS
Tubular axle induction motor for rail traction, 2:57067
ELECTRIC RAILWAYS/EQUIPMENT PROTECTION DEVICES
Line fault detectors for direct current railways, 2:57029
ELECTRIC UTILITIES
See PUBLIC UTILITIES
ELECTRICAL EQUIPMENT
See also CURRENT LIMITERS
ELECTRIC CONTACTS
RESISTORS
ELECTRICAL EQUIPMENT/AUTOMATION
Geamatic 2000 I, a new automation system for underground mining installations, 2:55705
ELECTRICAL EQUIPMENT/HAZARDS
West Virginia Univ. professors work for electrical safety, 2:55677

ELECTRICAL EQUIPMENT/SUPERCONDUCTING MAGNETS
Applications of superconducting magnets to energy with particular emphasis on fusion power, 2:57740
ELECTRIC-POWERED VEHICLES
See also ELECTRIC RAILWAYS
ELECTRIC-POWERED VEHICLES/DESIGN
Batteries for mail vans, 2:56908
Battery powered mail vans, 2:57070
ELECTRIC-POWERED VEHICLES/ELECTRIC BATTERIES
Batteries for the '80s: the materials of energy storage, 2:56890
ELECTRIC-POWERED VEHICLES/LEAD-ACID BATTERIES
Actual service life and bench cycle life of lead-acid battery for electric vehicle use, 2:56900
ELECTRIC-POWERED VEHICLES/LITHIUM-WATER-AIR BATTERIES
Researchers study new batteries, 2:56899
ELECTRIC-POWERED VEHICLES/NICKEL-ZINC BATTERIES
Researchers study new batteries, 2:56899
ELECTRIC-POWERED VEHICLES/PERFORMANCE
Electric mail delivery vans, 2:57068
ELECTRIC-POWERED VEHICLES/PERFORMANCE TESTING
Trolley-wire-operated underground locomotive with manual and remote control, including fully automatic control and speed regulation, 2:55706
ELECTRIC-POWERED VEHICLES/REVIEWS
Time for reality, 2:57069
ELECTRIC-POWERED VEHICLES/SODIUM-SULFUR BATTERIES
Sodium-sulfur battery, 2:56893
ELECTROMAGNETIC PUMPS/DESIGN
Electromagnetic induction pump (Patent; LMFBR), 2:56579
ELECTROMAGNETIC PUMPS/MATHEMATICAL MODELS
Distribution of the density of induced current along the height of an operational duct on an electrodynamic pump, 2:57306
ELECTRON BEAM ION SOURCES/DESIGN
Industrial ion source technology. Annual report, 2:57493 (N-77-16248)
ELECTRON BEAM ION SOURCES/PERFORMANCE
Industrial ion source technology. Annual report, 2:57493 (N-77-16248)
ELECTRON BEAM TYPE REACTORS
See E-BEAM TYPE REACTORS
ELECTRON BEAM WELDING
Electron beam welding using fusion and cold wire fill, 2:57090 (GEPP-297)
ELECTRON BEAMS/POLARIZED BEAMS
Recent advances in polarized-electron experiments, 2:57521
ELECTRON COLLISIONS
See also ELECTRON-ATOM COLLISIONS
ELECTRON-ION COLLISIONS
ELECTRON-MOLECULE COLLISIONS
ELECTRON COLLISIONS/BACKSCATTERING
Investigation of plasmon excitation by oblique incidence of a beam of primary electrons of medium energy in reflection experiments (50 to 500 eV, 0 to 88°), 2:57498
ELECTRON COLLISIONS/ELASTIC SCATTERING
Measurement of absolute collision cross sections of electrons elastically scattered by gases (Reviews), 2:57520
ELECTRON COLLISIONS/IONIZATION
Angular correlation of electrons coming from ionization by electron impact (Reviews), 2:57527
ELECTRON COLLISIONS/MEETINGS
Physics of electronic and atomic collisions, 2:57517
ELECTRON COLLISIONS/REVIEWS
Recent advances in polarized-electron experiments, 2:57521
ELECTRON DETACHMENT/THRESHOLD ENERGY
Photodetachment threshold processes (Cross sections), 2:57544
ELECTRON GUNS/FABRICATION
Simple, pulsed, electron beam gun (10A of 100-keV electrons), 2:57496
ELECTRON PLASMA WAVES/LANDAU DAMPING
Observation of nonlinear Landau damping of a broad-band spectrum of electron plasma waves, 2:57677
ELECTRON SOURCES
Electron-beam technology and electron-beam target experimental results, 2:57776
ELECTRON-ATOM COLLISIONS/ELASTIC SCATTERING
Elastic and total scattering of electrons by noble gases (Review), 2:57519
ELECTRON-ATOM COLLISIONS/EXCITATION
Absolute effective cross sections for the excitation of a strontium atom from metastable states by electron collision (Excitation functions), 2:57515
Electron impact excitation of light atoms (Review, cross sections), 2:57522
Electron scattering by laser-excited atoms, 2:57525
ELECTRON-ATOM COLLISIONS/INELASTIC SCATTERING
Inelastic electron-hydrogen atom experiments (Review), 2:57523
ELECTRON-ATOM COLLISIONS/WAVE FUNCTIONS
Theory of low-energy electron-atom collisions and related processes (Bound states), 2:57524
ELECTRONIC GUIDANCE/COOLING
Fusible heat sink for a cryogenic refrigerator, 2:57265 (AD-D-003515)
ELECTRON-ION COLLISIONS/AUTOIONIZATION
Energy exchanges between two escaping electrons, 2:57526
ELECTRON-ION COLLISIONS/IONIZATION
(e,2e) reaction, 2:57550
Energy exchanges between two escaping electrons, 2:57526
ELECTRON-MOLECULE COLLISIONS/DISSOCIATION
Fragmentation of aliphatic chlorocarbons under low-energy (< or approx. = 10 eV) electron impact, 2:57512
ELECTRON-MOLECULE COLLISIONS/EXCITATION
Multiple scattering approach to the vibrational excitation of molecules by slow electrons (Cross sections), 2:57529
ELECTRON-MOLECULE COLLISIONS/IONIZATION
(e,2e) reaction, 2:57550
Laser photodissociation of hydrogen molecule ions with fragment kinetic energy analysis, 2:57506
ELECTRON-MOLECULE COLLISIONS/RESONANCE SCATTERING
Classification of Feshbach resonances in electron-molecule scattering, 2:57530
ELECTRON-MOLECULE COLLISIONS/SCATTERING
Theory of low energy electron-molecule scattering (Reviews), 2:57528
ELECTRON-POSITRON INTERACTIONS/ANNIHILATION
Effects of neutral currents in the process of $e^+ e^-$ annihilation into a baryon-antibaryon pair, 2:57575
ELECTRON-POSITRON INTERACTIONS/WEAK NEUTRAL CURRENTS
Effects of neutral currents in the process of $e^+ e^-$ annihilation into a baryon-antibaryon pair, 2:57575
ELMO BUMPY TORUS/ENERGY BALANCE
EBT time-dependent point model code: description and user's guide, 2:57628 (ORNL/CSD/TM-27)
ELMO BUMPY TORUS/FEASIBILITY STUDIES
ELMO Bumpy Torus Reactor (EBTR) reference design study, 2:57714
EMERGENCIES
See ACCIDENTS
EMERGENCY CORE COOLING SYSTEM
See ECCS
EMERGENCY RODS
See SCRAM RODS
EMPLOYMENT
Job creation through energy conservation: a solution to a crisis (Massive program of weatherization, etc), 2:56918 (PB-265295)
ENERGY
See also GEOTHERMAL ENERGY
NUCLEAR ENERGY
SOLAR ENERGY
ENERGY/MANAGEMENT
Energy, environment, management, and systems, 2:56984
ENERGY/PRODUCTION
Energy flow patterns for 1975 (For 50 states, regions and total U.S.), 2:56982 (LA-6770)
ENERGY ACCOUNTING/MATHEMATICAL MODELS
Input-output analysis and energy intensities: a comparison of some methodologies, 2:56919
ENERGY CONSERVATION
European waste-to-energy systems: case study of Koersor, Denmark, 2:56980 (CONS/2103-3)
European waste-to-energy systems. Case study of Munich: Munich North IA and IB, Munich North II, Munich South IV and V, 2:56981 (CONS/2103-4)
European waste-to-energy systems: case study of Geneva-Cheneviers (Switzerland), 2:56987 (CONS/2103-2)
Fibers as renewable resources for industrial materials (Review and assessment), 2:56928 (PB-264561)
Organizing and operating a vanpool program: feasibility of vanpooling in Virginia. Final report, 2:56940 (PB-264635)
Recycling waste (Book), 2:56925
Some aspects of natural gas conservation, 2:57031
ENERGY CONSERVATION/BEHAVIOR
Energy savings via behavioral changes, 2:56947
ENERGY CONSERVATION/BUILDINGS
Energy, environment, management, and systems, 2:56984
ENERGY CONSERVATION/DATA
Energy and Virginia's future: a report of the Virginia Energy Resource Advisory Commission, 2:56949 (NP-21880)
ENERGY CONSERVATION/ECONOMIC IMPACT
Job creation through energy conservation: a solution to a crisis (Massive program of weatherization, etc), 2:56918 (PB-265295)

ENERGY CONSERVATION/ENVIRONMENTAL IMPACTS
Environmental implications of nontechnological methods to conserve energy, 2:56924
ENERGY CONSERVATION/FINANCIAL INCENTIVES
District heating pricing as an inducement for energy saving, 2:56912
ENERGY CONSERVATION/INVESTMENT
The costs of cold weather and the conservation of residential heating gas. Staff report (Cost-effective investments for each state), 2:57015 (PB-264759)
ENERGY CONSERVATION/SOCIAL IMPACT
Job creation through energy conservation: a solution to a crisis (Massive program of weatherization, etc), 2:56918 (PB-265295)
ENERGY CONSERVATION/SOCIO-ECONOMIC FACTORS
Report from Berkeley (Summary of 1975 summer study at LBL on Efficient Use of Energy in Buildings), 2:56946
ENERGY CONSERVATION/STANDARDS
Energy-conservation standards loom for buildings and industrial processes, 2:56942
ENERGY CONSERVATION/VIRGINIA
Energy and Virginia's future: a report of the Virginia Energy Resource Advisory Commission, 2:56949 (NP-21880)
ENERGY CONSUMPTION/ENERGY MODELS
Regional reference energy systems (Projection to year 2000), 2:56948 (EPRI-EA-462)
ENERGY CONSUMPTION/ENVIRONMENTAL EFFECTS
Planner's handbook on energy (with emphasis on residential uses), 2:57001 (NP-21852)
ENERGY CONSUMPTION/FLOW MODELS
Energy flow patterns for 1975 (For 50 states, regions and total U.S.), 2:56982 (LA-6770)
ENERGY CONSUMPTION/MANAGEMENT
Energy, environment, management, and systems, 2:56984
ENERGY CONSUMPTION/MATHEMATICAL MODELS
Input-output analysis and energy intensities: a comparison of some methodologies, 2:56919
ENERGY CONSUMPTION/REGIONAL ANALYSIS
Energy flow patterns for 1975 (For 50 states, regions and total U.S.), 2:56982 (LA-6770)
Regional reference energy systems (Projection to year 2000), 2:56948 (EPRI-EA-462)
ENERGY CONSUMPTION/SOCIO-ECONOMIC FACTORS
Energy savings via behavioral changes, 2:56947
Planner's handbook on energy (with emphasis on residential uses), 2:57001 (NP-21852)
Report from Berkeley (Summary of 1975 summer study at LBL on Efficient Use of Energy in Buildings), 2:56946
ENERGY CONVERSION/BIBLIOGRAPHIES
Energy, 2:57834
ENERGY DEMAND
Biological productivity of renewable resources used as industrial materials, 2:56926 (PB-264457)
ENERGY DEMAND/ECONOMETRICS
Household fuel demand analysis, 2:57013 (CONF-770225-1)
International comparisons of the residential demand for energy: a preliminary analysis (World Oil Project), 2:56952 (PB-265108)
ENERGY DEMAND/ECONOMIC ELASTICITY
Energy savings via behavioral changes, 2:56947
ENERGY DEMAND/FORECASTING
Can we do without uranium, 2:56936
Planner's handbook on energy (with emphasis on residential uses), 2:57001 (NP-21852)
ENERGY DEMAND/GLOBAL ASPECTS
International comparisons of the residential demand for energy: a preliminary analysis (World Oil Project), 2:56952 (PB-265108)
ENERGY FACILITIES/ACCIDENTS
Accidents and unscheduled events associated with non-nuclear energy resources and technology. Final report, 2:56923 (PB-265398)
ENERGY FACILITIES/ENVIRONMENTAL IMPACTS
Radiation levels in the vicinity of ERDA facilities, 2:57370
ENERGY MANAGEMENT
Energy conservation in dyeing and finishing (Textile industry), 2:56944
Practical meaning of energy management (Textile industry), 2:56943
ENERGY MODELS
Land use-energy simulation model: a computer-based model for exploring land use and energy relationships, 2:56915 (BNL-50634)
Overview of technological-economic models for energy policy analysis, 2:56954 (BNL-22730)
Project Independence evaluation system (PIES) documentation. Volume VII. Methodology for developing more complex investment and production profiles in the FEA oil and gas supply model, 2:56951 (PB-264649)
Regional reference energy systems (Projection to year 2000), 2:56948 (EPRI-EA-462)
ENERGY POLICY
Can we do without uranium, 2:56936
Environmental implications of nontechnological methods to conserve energy (Evaluation of future options), 2:56924
Impact of mandatory petroleum allocation, price, and other regulations on the profitability, competitive viability, and ease of entry of independent refiners and small refiners, 2:56972 (PB-265143)
Plutonium recycle's relation to the future of nuclear power, 2:56937
Report on the Western Energy Expansion Study, 2:56986 (NP-22295)
ENERGY POLICY/COMPARATIVE EVALUATIONS
Energy policies of France Great Britain, and Germany compared, 2:56959
ENERGY POLICY/EVALUATION
Efficient energy utilization in the European Community: tasks, aims, and tools of the common policy of efficient energy utilization, 2:56945
ENERGY POLICY/NUCLEAR ENERGY
Emerging role of FEA in nuclear energy expansion, 2:56939
ENERGY POLICY/SIMULATION
Overview of technological-economic models for energy policy analysis, 2:56954 (BNL-22730)
ENERGY SOURCE DEVELOPMENT/ACCIDENTS
Accidents and unscheduled events associated with non-nuclear energy resources and technology. Final report, 2:56923 (PB-265398)
ENERGY SOURCE DEVELOPMENT/ECONOMIC IMPACT
State taxation of mineral deposits and production. Final report (Western states), 2:56956 (PB-264575)
ENERGY SOURCE DEVELOPMENT/ENVIRONMENTAL IMPACTS
Biological productivity of renewable resources used as industrial materials, 2:56926 (PB-264457)
Environmental research outlook for FY 1977 through FY 1981: report to Congress, 2:56922 (PB-264529)
Reference materials system: a source for renewable materials assessment, 2:56927 (PB-264494)
ENERGY SOURCE DEVELOPMENT/PLANNING
Proceedings of the public meeting to review the status of the inexhaustible energy resources study, 2:56985 (CONF-770560-)
ENERGY SOURCE DEVELOPMENT/REVIEWS
Proceedings of the public meeting to review the status of the inexhaustible energy resources study, 2:56985 (CONF-770560-)
ENERGY SOURCE DEVELOPMENT/SOCIAL IMPACT
State taxation of mineral deposits and production. Final report (Western states), 2:56956 (PB-264575)
ENERGY SOURCES
See also FOSSIL FUELS
NUCLEAR FUELS
WASTE HEAT
WAVE POWER
WIND POWER
Free' and renewable energy sources, 2:56170
ENERGY SOURCES/AVAILABILITY
Energy and natural resources, 2:56930
ENERGY SOURCES/BIBLIOGRAPHIES
Energy, 2:57834
ENERGY SOURCES/DATA
Energy and Virginia's future: a report of the Virginia Energy Resource Advisory Commission, 2:56949 (NP-21880)
ENERGY SOURCES/ENVIRONMENTAL EFFECTS
Proceedings of a workshop on the measure of intangible environmental impacts, 2:57403 (EPRI-EA-405-SR)
ENERGY SOURCES/EVALUATION
Reference materials system: a source for renewable materials assessment, 2:56927 (PB-264494)
ENERGY SOURCES/FLOWSHEETS
Energy flow patterns for 1975 (For 50 states, regions and total U.S.), 2:56982 (LA-6770)
ENERGY SOURCES/FORECASTING
Biological productivity of renewable resources used as industrial materials, 2:56926 (PB-264457)
ENERGY SOURCES/HEALTH HAZARDS
Biohazards of energy production, distribution, use, and conservation: information sources, 2:57460 (CONF-7605159-1)
ENERGY SOURCES/INDEXES
Energy, 2:57834
ENERGY SOURCES/REVIEWS
Economic approaches to long-term energy source selection, 2:57700
ENERGY SOURCES/SIMULATION
A directory of computer software applications: energy. Report for 1974-1976, 2:56909 (PB-264200)
ENERGY SOURCES/VIRGINIA
Energy and Virginia's future: a report of the Virginia Energy Resource Advisory Commission, 2:56949 (NP-21880)

ENERGY STORAGE
See also COMPRESSED AIR ENERGY STORAGE
FLYWHEEL ENERGY STORAGE
HYDROGEN STORAGE
OFF-PEAK ENERGY STORAGE
PUMPED STORAGE
Energy storage during orbital and interplanetary missions, 2:56883 (AED-CONF-76-377-002)
ENERGY STORAGE/BIBLIOGRAPHIES
Energy, 2:57834
ENERGY STORAGE/FEASIBILITY STUDIES
Economic feasibility of a fusion-based energy storage system, 2:57741
ENERGY STORAGE/SUPERCONDUCTING MAGNETS
Applications of superconducting magnets to energy with particular emphasis on fusion power, 2:57740
ENERGY SUPPLIES/DATA
Energy and Virginia's future: a report of the Virginia Energy Resource Advisory Commission, 2:56949 (NP-21880)
ENERGY SUPPLIES/ECONOMIC ELASTICITY
Project Independence evaluation system (PIES) documentation. Volume VI. Methodology for improving the price sensitivity of the PIES oil and gas supply curves, 2:56950 (PB-264069)
ENERGY SUPPLIES/ENERGY MODELS
Project Independence evaluation system (PIES) documentation. Volume VII. Methodology for developing more complex investment and production profiles in the FEA oil and gas supply model, 2:56951 (PB-264649)
Regional reference energy systems (Projection to year 2000), 2:56948 (EPRI-EA-462)
ENERGY SUPPLIES/FORECASTING
Can we do without uranium, 2:56936
ENERGY SUPPLIES/GLOBAL ASPECTS
Recent new oil sources and their implications for world energy, 2:55760
ENERGY SUPPLIES/REGIONAL ANALYSIS
Regional reference energy systems (Projection to year 2000), 2:56948 (EPRI-EA-462)
ENERGY SUPPLIES/SIMULATION
A directory of computer software applications: energy. Report for 1974-1976, 2:56909 (PB-264200)
ENERGY SUPPLIES/VIRGINIA
Energy and Virginia's future: a report of the Virginia Energy Resource Advisory Commission, 2:56949 (NP-21880)
ENERGY TRANSPORT
See also NATURAL GAS DISTRIBUTION SYSTEMS
ENERGY TRANSPORT/BIBLIOGRAPHIES
Energy, 2:57834
ENERGY TRANSPORT/COMPARATIVE EVALUATIONS
Alternative forms of energy transmission from OTEC plants (Chemical and electrical), 2:56089 (CONF-770331-5)
ENERGY TRANSPORT/THERMAL ENERGY STORAGE EQUIPMENT
Alternative energy transmission systems from OTEC plants. Project 8980 third quarter progress report, January 1-March 31, 1977 (Study on 4 thermal storage systems), 2:56091 (DSE/2426-12)
ENGINEERED SAFETY SYSTEMS
See also AIR CLEANING SYSTEMS
CONTAINMENT SYSTEMS
ECCS
ENGINEERED SAFETY SYSTEMS/FAILURES
On the probability of loss of dc power following ac failure in a nuclear power plant, 2:56791 (PB-265099)
ENGINES
See also DIESEL ENGINES
INTERNAL COMBUSTION ENGINES
ENGINES/WEAR
Role of antiwear additives for lube oils in a friction test simulating ring-liner contact, 2:55775
ENGLAND
See UNITED KINGDOM
ENRICHED URANIUM/FORECASTING
Outlook for uranium and enrichment supply in the United States, 2:55852
Uranium requirements for fuel cycles in expanding nuclear power systems, 2:55895
ENRICHED URANIUM/PRODUCTION
Enrichment prospects for the 1980's, 2:55865
Optimal set of selected enrichments that minimizes blending consequences, 2:55894
ENVIRONMENT
Energy, environment, management, and systems, 2:56984
Proceedings of a workshop on the measure of intangible environmental impacts, 2:57403 (EPRI-EA-405-SR)
ENVIRONMENT/RADIATION MONITORING
Status report on environmental radioactivity monitoring in the Federal Republic of Germany, 2:57367 (STH-6/76)
ENVIRONMENT/RESEARCH PROGRAMS
Environmental research outlook for FY 1977 through FY 1981: report to Congress, 2:56922 (PB-264529)
ENVIRONMENTAL EFFECTS/DATA ANALYSIS
Proceedings of a workshop on the measure of intangible environmental impacts, 2:57403 (EPRI-EA-405-SR)
ENVIRONMENTAL EFFECTS/RESEARCH PROGRAMS
Proceedings of a workshop on the measure of intangible environmental impacts, 2:57403 (EPRI-EA-405-SR)
ENVIRONMENTAL EFFECTS/SOCIO-ECONOMIC FACTORS
Proceedings of a workshop on the measure of intangible environmental impacts, 2:57403 (EPRI-EA-405-SR)
ENVIRONMENTAL IMPACT STATEMENTS
Environmental impact analysis of Coyote Station. Volume 1, 2:56344 (NP-22244(Vol.1))
Environmental impact analysis of Coyote Station. Volume 2, 2:56357 (NP-22244(Vol.2))
ENVIRONMENTAL PROTECTION AGENCY/RESEARCH PROGRAMS
Environmental research outlook for FY 1977 through FY 1981: report to Congress, 2:56922 (PB-264529)
ENZYMES
See also DNA-ASE
GLYCOSYL HYDROLASES
NUCLEASES
OXIDASES
ENZYMES/QUANTITATIVE CHEMICAL ANALYSIS
New portable centrifugal fast analyzer with expanded versatility, 2:57201 (CONF-770332-1)
EPA
See ENVIRONMENTAL PROTECTION AGENCY
EPITHELIUM/MORPHOLOGICAL CHANGES
Organ culture-cell culture system for studying multistage carcinogenesis in respiratory epithelium (Mice), 2:57453 (CONF-770342-2)
EPOXIDES/DEGASSING
Organics used in microelectronics: a review of outgassing materials and effects, 2:57173 (SAND-76-5854C)
EPOXY COMPOUNDS
See EPOXIDES
EQUATIONS (DIFFERENTIAL)
See DIFFERENTIAL EQUATIONS
EQUIPMENT INTERFACES/SPECIFICATIONS
Emmy/Unibus interface design specification. Technical note No. 109, 2:57815 (SU-326-P.39-19)
ESTUARINE ECOSYSTEMS
See AQUATIC ECOSYSTEMS
ETHANE/COMBUSTION KINETICS
Computational simulation of shock-induced gas-phase reactions, 2:57247
ETHANE/HOT ATOM CHEMISTRY
Gas to liquid to solid transition in halogen hot atom chemistry. IV. The suggestion of multiple enhancement reactions in high energy iodine-128-ethane systems, 2:57240
ETHINE
See ACETYLENE
ETHYLENE/CHEMICAL RADIATION EFFECTS
Substituting polyketones and polysulfones for polyethylene, 2:57171
ETHYLENE/COPOLYMERIZATION
Substituting polyketones and polysulfones for polyethylene, 2:57171
ETHYLENE/CRYSTALLOGRAPHY
Surface crystallography of clean platinum single crystals and adsorbed hydrocarbon overlayers studied by low energy electron diffraction, 2:57211 (LBL-6221)
ETHYLENE/EXCITED STATES
SCF-stabilization approach to excited states embedded in the continuum, 2:57554
ETHYLENE/HOT ATOM CHEMISTRY
Gas to liquid to solid transition in halogen hot atom chemistry. IV The suggestion of multiple enhancement reactions in high energy iodine-128-ethane systems, 2:57240
ETHYLENE/PRODUCTION
Natural gas: feedstock for ethylene plants, 2:55808
ETHYLENE POLYMERS
See POLYETHYLENES
ETHYLENEDIAMINETETRAACETIC ACID
See EDTA
ETHYNE
See ACETYLENE
EUROPE
See also CZECHOSLOVAKIA
FRANCE
GERMAN DEMOCRATIC REPUBLIC
GERMAN FEDERAL REPUBLIC
ITALY

POLAND
SWITZERLAND
UNITED KINGDOM
USSR
YUGOSLAVIA
Petropolitics and the Atlantic Alliance (Short- and long-term effects of petroleum crisis), 2:56969 (AD-A-037807)
EUROPE/CHEMICAL INDUSTRY
Structural change in feedstocks supply for the petrochemicals industry, 2:55778
EUROPE/ENERGY CONSERVATION
European waste-to-energy systems. An overview, 2:57022 (CONS/2103-6)
EUROPE/WASTE HEAT UTILIZATION
European waste-to-energy systems. An overview, 2:57022 (CONS/2103-6)
EUROPEAN COMMUNITIES
See also COMMON MARKET
EUROPEAN COMMUNITIES/COAL INDUSTRY
Present situation of the European Community coal mining industry, 2:56965
EUROPEAN COMMUNITIES/COAL RESERVES
Present situation of the European Community coal mining industry, 2:56965
EUROPEAN COMMUNITIES/ENERGY EFFICIENCY
Efficient energy utilization in the European Community: tasks, aims, and tools of the common policy of efficient energy utilization, 2:56945
EUROPEAN COMMUNITIES/ENERGY POLICY
Efficient energy utilization in the European Community: tasks, aims, and tools of the common policy of efficient energy utilization, 2:56945
EUROPIUM BORIDES/CHEMICAL PREPARATION
Synthesis and fabrication of EuB_6, 2:56726
EUROPIUM BORIDES/FABRICATION
Synthesis and fabrication of EuB_6, 2:56726
EVAPORATIVE COOLING/EFFICIENCY
Statistical investigation of the efficiency of solar and evaporative coolers in the conditions of Turkmenia, 2:56101
EVAPORATORS/TWO-PHASE FLOW
Effect of pressure loss components on dynamic stability of water-steam mixture flow in once through steam generator channel, 2:56688
EXCURSIONS
Model to predict core pressure during a transient overpower (TOP), 2:56831
Parametric safety analyses for reduced energetics in PLBR-sized cores, 2:56824
EXCURSIONS/COMPUTER CODES
Comparison of the EPIC and PLUTO computer codes for TOP conditions, 2:56825
EXCURSIONS/FISSION PRODUCT RELEASE
Coupled fission gas release and molten fuel motion model for slow overpower transients, 2:56855
EXCURSIONS/FUEL ELEMENT FAILURE
Cladding temperatures, deformations, and failure thresholds during power bursts, 2:56807
EXCURSIONS/MELTDOWN
Coupled fission gas release and molten fuel motion model for slow overpower transients, 2:56855
EXHAUST GASES/CHEMICAL COMPOSITION
Exhaust gas emissions of Brown Boveri gas turbines, 2:56347
EXPERIMENT PLANNING/MATHEMATICAL MODELS
Designs for the detection of inadequacy in factorial models, 2:57813 (ORNL/CSD/TM-30)
EXPERIMENTAL BREEDER REACTOR-2
See EBR-2 REACTOR
EXPLORATION
See also GEOTHERMAL EXPLORATION
EXPLORATION/DATA COMPILATION
Data base for analyzing results of oil and gas exploration, 2:55748
EXPLORATION/MANAGEMENT
Data base for analyzing results of oil and gas exploration, 2:55748
EXPONENTIAL PILES
See SUBCRITICAL ASSEMBLIES

F

F CODES/COMPUTER CODES
Numerical calculation of the transonic flow past a swept wing (FLO 22), 2:57251 (COO-3077-140)
FAILED ELEMENT MONITORS/DESIGN
Apparatus for inspecting failed fuel (Patent), 2:56399
Apparatus for inspecting failed fuel (Patent; BWR), 2:56400
Method and apparatus for failed fuel detection (Patent; BWR), 2:56402
FALLOUT
(For radioactive fallout only.)
FALLOUT/RADIATION MONITORING
Plutonium in human lung in the Hanford environs, 2:57436 (BNWL-SA-5855)
FANS
See BLOWERS
FARADAY GENERATORS
See MHD GENERATORS
FAST BREEDER BLANKET FACILITY (FBBF)
See SUBCRITICAL ASSEMBLIES
FAST FLUX TEST FACILITY REACTOR
See FFTF REACTOR
FAST NEUTRONS/COLLISIONS
Sputtering of niobium by energetic neutrons and protons: A round-robin experiment (MeV range), 2:57494
FAST REACTORS
See also FFTF REACTOR
GCFR TYPE REACTORS
LMFBR TYPE REACTORS
FAST REACTORS/ACOUSTIC MEASUREMENTS
Calculation of basic resonances for acoustic vibration in fast reactors, 2:56568
FAST REACTORS/FUEL CYCLE
Nuclear fuel cycle: (4) the reactors, 2:56606
FAST REACTORS/REACTOR KINETICS
Fast reactor transfer functions with special reference to the nonlinearities and the spatial dependence of the heat transfer process, 2:56646
Improved response matrix method and its verification by one-dimensional analysis on fast reactors, 2:56650
Wigner-type continuous slowing down theory for the fast-neutron spectrum, 2:56644
FAST REACTORS/REACTOR MATERIALS
Isotopically tailored materials for fission and fusion reactors, 2:56652 (MLM-2426(OP))
Simulation of void swelling: a critical review, 2:56654
FAST REACTORS/REACTOR PROTECTION SYSTEMS
Investigation of self-starting of controlled drives in the system of own requirements of nuclear power plants with fast reactors in conditions of emergency cooling-down, 2:56874
FAST REACTORS/RESONANCE
Calculation of basic resonances for acoustic vibration in fast reactors, 2:56568
FASTENERS
Rotor for wind-driven machine (Patent), 2:56223
FEDERAL REPUBLIC OF GERMANY
See GERMAN FEDERAL REPUBLIC
FEEDWATER/ADDITIVES
Erroneousness of adding hydrogen peroxide into boiler unit tract with brass low-pressure heaters, 2:56297
FEEDWATER/ELECTRIC CONDUCTIVITY
Water chemistry in Swedish boiling water reactors: operational experience, 2:56376
FEEDWATER/ELECTROLYTES
Water chemistry in Swedish boiling water reactors: operational experience, 2:56376
FEEDWATER/FILTERS
Experience of industrial operation of wash-in cartridge filters in chemical water purification schemes of nuclear power plants, 2:56686
Investigation of magnetic filters for iron removal from feedwater of steam generators at nuclear power plants, 2:56687
FEEDWATER/WATER CHEMISTRY
Water chemistry in Swedish boiling water reactors: operational experience, 2:56376
FERMI LEVEL
Dielectric screening in one-dimensional disordered systems, 2:57624
FERMILAB ACCELERATOR/ON-LINE CONTROL SYSTEMS
Precision position control and monitoring via CAMAC, 2:57331
FERMIONS
See also BARYONS
FERMIONS/BOUND STATE
Non-Abelian gauge fields and nonrelativistic bound states, 2:57579
FERROELECTRIC MATERIALS/PHASE TRANSFORMATIONS
Some applications of high pressure studies of phase transitions in solids, 2:57175 (SAND-77-0104C)
FERROMAGNETIC MATERIALS/PHASE TRANSFORMATIONS
Some applications of high pressure studies of phase transitions in solids, 2:57175 (SAND-77-0104C)
FERTILIZERS/PRODUCTION
Pasteur v curie, 2:55971
FFTF REACTOR/LOSS OF FLOW
Final report on Test L4, a loss-of-flow experiment, 2:56766 (ANL-76-130)

FFTF REACTOR/REACTOR ACCIDENTS
Comparison of 2D and 3D diffusion theory codes for transition-phase modeling of distorted subassemblies, 2:56778 (HEDL-TME-77-26)
FFTF REACTOR/REACTOR CORE DISRUPTION
Influence of equation-of-state uncertainties on fuel vapor expansion work-energy calculations, 2:56847
FFTF REACTOR/SPENT FUEL STORAGE
Design of the FFTF fuel storage facility (FSF), 2:56760
FIBERS
Fibers as renewable resources for industrial materials (Review and assessment), 2:56928 (PB-264561)
FIBERS/LIGHT TRANSMISSION
Technique for measuring optical fiber transmission using the time dispersion of Cerenkov radiation, 2:57309
FILTERS/MATERIALS
Status of Wilsonville Solvent Refined Coal pilot plant. Interim report, 2:55601 (EPRI-1234)
FILTERS/SERVICE LIFE
Status of Wilsonville Solvent Refined Coal pilot plant. Interim report, 2:55601 (EPRI-1234)
FINITE DIFFERENCE METHOD/COMPARATIVE EVALUATIONS
Survey of numerical methods for compressible fluids, 2:57560 (COO-3077-145)
FINITE ELEMENT METHOD/BOUNDARY CONDITIONS
Equating degrees of freedom in the SAP finite element code, 2:57809 (K/CSD/TM-13)
FINITE ELEMENT METHOD/COORDINATES
INGEN: a general purpose mesh generator for finite element codes, 2:57812 (LA-UR-77-1345)
FIRST WALL/COST
First-wall costs of an ion-beam fusion reactor, 2:57794
FIRST WALL/DESIGN
First wall and blanket design for an ICTR, 2:57781
FIRST WALL/IMPURITIES
First-wall characterization of tokamaks by in situ auger electron spectroscopy, 2:57801
FIRST WALL/LIFETIME
Lifetime considerations for a fusion reactor first wall of type 316 stainless steel, 2:57795
FIRST WALL/MATERIALS
Structure of chemical vapor deposited silicon carbide, 2:57155
FIRST WALL/MECHANICAL PROPERTIES
First wall thermal-mechanical analyses of the reference theta-pinch reactor, 2:57719
FIRST WALL/PHYSICAL RADIATION EFFECTS
Sputtering of niobium by energetic neutrons and protons: A round-robin experiment, 2:57494
FIRST WALL/SPUTTERING
Modeling and analysis of impurity control techniques for tokamak fusion reactors, 2:57800
FIRST WALL/THERMAL STRESSES
First wall thermal-mechanical analyses of the reference theta-pinch reactor, 2:57719
Heat transfer and stress problems associated with ICTR walls, 2:57782
FIRST WALL/VAPOR DEPOSITED COATINGS
Structure of chemical vapor deposited silicon carbide, 2:57155
FISCHER-TROPSCH SYNTHESIS/CHEMICAL REACTION KINETICS
Molecular-chain buildup in the FT synthesis, 2:55772
FISCHER-TROPSCH SYNTHESIS/ECONOMICS
Petrochemical basic products from coal, 2:55627
FISHES
See also TUNA
Fishing for toxicity: biological automonitor for continuous water quality control, 2:57396
pH and haemoglobin oxygen affinity in blood from the antarctic cod Dissostichus mawsoni, 2:57442
FISHES/ANIMAL GROWTH
The age and growth of the largemouth bass 'Micropterus salmoides' (lacepede), in a thermally loaded reservoir, 2:57441 (PB-264914)
FISHES/PHYSIOLOGY
Trace metal toxicity in aquatic teleosts (fishes), 2:57454
FISHES/TEMPERATURE EFFECTS
Impact of thermal effluents on fish, 2:57443
FISSILE MATERIALS
(Materials containing nuclides capable of undergoing fission by interaction with slow neutrons.)
FISSILE MATERIALS/CRITICALITY
Reactivity enhancement in transportation and storage arrays due to fissile material density reductions, 2:57274
FISSILE MATERIALS/RAIL TRANSPORT
Shock and vibration environments for large shipping containers on rail cars and trucks, 2:57278 (SAND-76-0427)
FISSILE MATERIALS/REACTIVITY
Reactivity enhancement in transportation and storage arrays due to fissile material density reductions, 2:57274
FISSION FOIL DETECTORS/CALIBRATION
Monte Carlo calculations of cadmium cutoff energies and an ansatz formula, 2:56759
FISSION FRAGMENTS/ANGULAR CORRELATION
Angular-momentum transfer in deeply inelastic scattering of 610-MeV ^{86}Kr by ^{209}Bi (Angular correlations of fragments from fissioning heavy reaction products), 2:57599
FISSION FRAGMENTS/ANGULAR DISTRIBUTION
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction, 2:57600
FISSION FRAGMENTS/KINETIC ENERGY
Manifestations of the viscosity of a fissioning nucleus in the kinetic energy of the fragments, 2:57610
FISSION FRAGMENTS/X-RAY SPECTRA
X rays from fragments in fission of ^{235}U by 3.5-MeV neutrons, 2:57609
FISSION PRODUCTS/DECAY
ENDF/B fission product decay data, 2:57588 (BNL-NCS-50545(Vol.1))
ENDF/B fission product decay data, 2:57589 (BNL-NCS-50545(Vol.2))
FISSION PRODUCTS/NUCLEAR DATA COLLECTIONS
ENDF/B fission product decay data, 2:57588 (BNL-NCS-50545(Vol.1))
ENDF/B fission product decay data, 2:57589 (BNL-NCS-50545(Vol.2))
FISSION PRODUCTS/SLOWING-DOWN
Atomic collisions and fission technology, 2:57621
FISSIONABLE MATERIALS MANAGEMENT
See NUCLEAR MATERIALS MANAGEMENT
FLAME PROPAGATION
Flame suppression on cylindrical fuel rods, 2:57248
FLAMES/ULTRAVIOLET SPECTRA
Investigation of visible and ultraviolet emission from fuel oil flames on an industrial scale, 2:57318
FLASHED STEAM SYSTEMS/DESIGN
Method of removing dissolved non-condensibles from geothermal brines (Patent), 2:56199
FLASKS
See CASKS
FLAT PLATE COLLECTORS/COATINGS
Low cost coatings for flat plate solar collectors, 2:56126
FLAT PLATE COLLECTORS/COST
Considerations in the development of a high performance per unit cost solar collector, 2:56143
FLAT PLATE COLLECTORS/COVERINGS
Heat mirror: a practical alternative to the selective absorber, 2:56150
FLAT PLATE COLLECTORS/FABRICATION
Heat pipes applied to flat-plate solar collectors. Final report, 2:56119 (COO/2604-76/1)
FLAT PLATE COLLECTORS/HEAT PIPES
Heat pipes applied to flat-plate solar collectors. Final report, 2:56119 (COO/2604-76/1)
FLAT PLATE COLLECTORS/HYBRID SYSTEMS
Extension of the Hottel-Whillier-Bliss model to the analysis of combined photovoltaic/thermal flat plate collectors, 2:56067
FLAT PLATE COLLECTORS/PERFORMANCE
Considerations in the development of a high performance per unit cost solar collector, 2:56143
FLAT PLATE COLLECTORS/PERFORMANCE TESTING
Design and tests of flat-plate solar collectors, 2:56121
Engineering analysis and testing of water-trickle solar collector, report No. 3. Progress report, June 1975-November 1976, 2:56120 (ORO/4927-77/1)
Heat pipes applied to flat-plate solar collectors. Final report, 2:56119 (COO/2604-76/1)
FLAT PLATE COLLECTORS/SPECTRALLY SELECTIVE SURFACES
Financial incentives for the fabrication of improved absorption coatings for the flat plate collector, 2:56142
FLAT PLATE COLLECTORS/TEST FACILITIES
Engineering analysis and testing of water-trickle solar collector, report No. 3. Progress report, June 1975-November 1976, 2:56120 (ORO/4927-77/1)
FLAT PLATE COLLECTORS/THERMAL ANALYSIS
Extension of the Hottel-Whillier-Bliss model to the analysis of combined photovoltaic/thermal flat plate collectors, 2:56067
FLOORS/LATENT HEAT STORAGE
Thermocrete heat storage materials: applications and performance specifications, 2:56167
FLORIDA/ENERGY POLICY
Planner's handbook on energy (with emphasis on residential uses), 2:57001 (NP-21852)

FLOW BLOCKAGE
Detection of a partial blockage in a heterogeneous core (LMFBR), 2:56476 (ANL-CT-77-30)
FLOW BLOCKAGE/SIMULATION
BOBL code. Experimental verification of the hydraulic model, including effects of pin bowing and grids (LMFBR), 2:56536 (ECN-9)
FLOW REGULATORS
See also VALVES
FLOW REGULATORS/DESIGN
Device for increasing fluid resistance in a core vessel cooling system (Patent), 2:56704
FLUE GAS/CHEMICAL COMPOSITION
Lowering of pollutant content in emissions from fuel combustion in boilers of middle capacity, 2:55791
FLUE GAS/DENITRIFICATION
Removal of contaminants from industrial gaseous effluents, 2:55654
FLUE GAS/DESULFURIZATION
Removal of contaminants from industrial gaseous effluents, 2:55654
Report of the Hearing Panel: National Public Hearing on Power Plant Compliance with Sulfur Oxide Air Pollution Regulations, conducted October 18, 1973 through November 2, 1973, 2:56346 (PB-264891)
FLUE GAS/RECOVERY
Recovery of flare gases: a technical process for economical use of flare gases, 2:55769
FLUE GAS/SCRUBBING
Characterization of ash from coal-fired power plants. Milestone report May 75-Mar 76, 2:55649 (PB-265374)
FLUE GAS/TEMPERATURE MEASUREMENT
Determination of balance temperatures along the gas tract of the boiler by means of reduced fuel characteristics, 2:57323
FLUID MECHANICS/COMPRESSIBLE FLOW
Survey of numerical methods for compressible fluids, 2:57560 (COO-3077-145)
FLUID MECHANICS/IDEAL FLOW
Survey of numerical methods for compressible fluids, 2:57560 (COO-3077-145)
FLUID WITHDRAWAL/SEISMIC EFFECTS
Seismicity and faulting attributable to fluid extraction, 2:55794
FLUIDIZED BED/ENERGY DEMAND
Energy oriented study of fluidized bed systems, 2:57036 (TREE-1135)
FLUIDIZED BED/HEAT TRANSFER
Study of the mean particle diameter as related to the particle size distribution and the heat transfer rate from tubes immersed in a fluidized bed, 2:57297 (TID-27676)
FLUIDIZED BED/PARTICLE SIZE
Study of the mean particle diameter as related to the particle size distribution and the heat transfer rate from tubes immersed in a fluidized bed, 2:57297 (TID-27676)
FLUIDIZED-BED COMBUSTORS/ENERGY DEMAND
Energy oriented study of fluidized bed systems, 2:57036 (TREE-1135)
FLUIDIZED-BED COMBUSTORS/MEASURING INSTRUMENTS
Particulate analysis instrumentation for fluidized-bed combustion systems, 2:55726 (FE-2412-T-1)
FLUORINATED ALIPHATIC HYDROCARBONS/MOLECULE-MOLECULE COLLISIONS
Study of momentum transfer distributions in rotationally inelastic collisions (Peripheral collisions, anisotropy), 2:57551
FLUORINATED AROMATIC HYDROCARBONS/CHEMICAL RADIATION EFFECTS
Radiation-induced homolytic aromatic substitution. VI. The effect of metal ions on the hydroxylation of benzonitrile, anisole, and fluorobenzene, 2:57236
FLUORINATED AROMATIC HYDROCARBONS/HYDROXYLATION
Radiation-induced homolytic aromatic substitution. VI. The effect of metal ions on the hydroxylation of benzonitrile, anisole, and fluorobenzene, 2:57236
FLUORINE/ION-ATOM COLLISIONS
Long-range interactions of ions with atoms having partially filled p subshells (Born-Oppenheimer approximation), 2:57513
FLUORINE IONS/COLLISIONS
Model of secondary electron yields from atomic and polyatomic ion impacts on copper and tungsten surfaces based upon stopping-power calculations, 2:57495
FLY ASH/CHEMICAL COMPOSITION
Contamination of groundwater by heavy metals from the land disposal of fly ash. Technical progress report, September 1, 1976-May 31, 1977, 2:57378 (COO-2727-5)
FLY ASH/PERMEABILITY
Permeability of fly ash and fly ash stabilized soils. Final report on highway research project no. 47, 2:55648 (PB-265229)
FLY ASH/REMOVAL
Dustfree removal of electrically filtered flyash experiences with screening, 2:55651
FLY ASH/USES
Permeability of fly ash and fly ash stabilized soils. Final report on highway research project no. 47, 2:55648 (PB-265229)
FLY ASH/WASTE DISPOSAL
Contamination of groundwater by heavy metals from the land disposal of fly ash. Technical progress report, September 1, 1976-May 31, 1977, 2:57378 (COO-2727-5)
FLYWHEEL ENERGY STORAGE/FEASIBILITY STUDIES
Flywheels: energy saving way to go, 2:57071
FLYWHEEL ENERGY STORAGE/RESEARCH PROGRAMS
Fiber-composite flywheel program. Quarterly progress report, January-March 1977, 2:56886 (UCRL-50033-77-1)
FLYWHEELS/ULTRASONIC TESTING
Ultrasonic data acquisition, analysis, and display by minicomputer aided techniques, 2:57308 (SAND-77-0526C)
FM DEVICES/ENERGY LOSSES
Energy loss rates of energetic ions injected into the FM-1 spherator, 2:57632
FM DEVICES/NEUTRAL ATOM BEAM INJECTION
Energy loss rates of energetic ions injected into the FM-1 spherator, 2:57632
FOCK METHOD
See HARTREE-FOCK METHOD
FOILS/ION COLLISIONS
Electronic state alignment, orientation, and coherence produced by beam-foil collisions, 2:57499
FORESTS
Biological productivity of renewable resources used as industrial materials, 2:56926 (PB-264457)
Reference materials system: a source for renewable materials assessment, 2:56927 (PB-264494)
FORESTS/CONTAMINATION
Assessment of potential radiation dose-to-man from an acute tritium release into a forest ecosystem, 2:57382 (DP-MS-76-89)
FORSCHUNGSREAKTOR GEESTHACHT-2
See FRG-2 REACTOR
FORTISSIMO REACTOR
See RAPSODIE REACTOR
FOSSIL FUELS
See also COAL
KEROSENE
NATURAL GAS
PEAT
PETROLEUM
SYNTHETIC FUELS
Equivalence between electricity and fuels: elements for a critical discussion, 2:56960
FOSSIL FUELS/COMBUSTION
Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, 11 September-10 December 1976 (5 refs), 2:55723 (FE-2018-6)
FOSSIL FUELS/COMPARATIVE EVALUATIONS
Health hazards of not going nuclear, 2:56938
FOSSIL-FUEL POWER PLANTS/AIR POLLUTION
The chemistry, dispersion and transport of air pollutants emitted from fossil fuel power plants in California: chemical analysis of particulate samples for sulfate, nitrate, and trace element composition. Final report, Sep-Nov 1974, 2:57358 (PB-264823)
The chemistry, dispersion, and transport of air pollutants emitted from fossil fuel power plants in California: data analysis and emission impact model. Final report, 2:57357 (PB-264822)
FOSSIL-FUEL POWER PLANTS/ASHES
Characterization of ash from coal-fired power plants. Milestone report May 75-Mar 76, 2:55649 (PB-265374)
FOSSIL-FUEL POWER PLANTS/AVAILABILITY
Action Plan for improving power plant productivity (Comparison of two nuclear and two coal-fired plants), 2:56594 (PB-264565)
Power plant productivity. Analysis report (Comparison of two nuclear and two coal-fired plants), 2:56591 (PB-264467)
Power plant productivity: an assessment of outages at two coal-fired and two nuclear plants, 2:56593 (PB-264564)
Productivity improvement action plan, 2:56592 (PB-264468)
FOSSIL-FUEL POWER PLANTS/CHEMICAL EFFLUENTS
Chalk Point Cooling Tower Project. Volume 1. Phase IV, comprehensive field program description. Environmental Systems Corporation's comprehensive project final report, October 1, 1975-June 30, 1976, 2:57362 (PPSP-CPCTP-12(Vol.1))
FOSSIL-FUEL POWER PLANTS/COASTAL REGIONS
Chalk Point Cooling Tower Project. Volume 2. Summer seasonal test data. Environmental Systems Corporation's comprehensive project final report, October 1, 1975-June 30, 1976, 2:57363 (PPSP-CPCTP-12(Vol.2))
FOSSIL-FUEL POWER PLANTS/COMBUSTION PRODUCTS
Radioactive residual matter. II, 2:55728

FOSSIL-FUEL POWER PLANTS/CONSTRUCTION
Effect of land value on construction costs of thermal and nuclear power plants, 2:56365
FOSSIL-FUEL POWER PLANTS/COST
Effect of land value on construction costs of thermal and nuclear power plants, 2:56365
FOSSIL-FUEL POWER PLANTS/DESIGN
Gas turbine power plants of large unit capacity in standard construction, 2:56228
FOSSIL-FUEL POWER PLANTS/ENVIRONMENTAL EFFECTS
Chalk Point Cooling Tower Project. Volume 1. Phase IV, comprehensive field program description. Environmental Systems Corporation's comprehensive project final report, October 1, 1975-June 30, 1976, 2:57362 (PPSP-CPCTP-12(Vol.1))
FOSSIL-FUEL POWER PLANTS/ENVIRONMENTAL IMPACT STATEMENTS
Environmental impact analysis of Coyote Station. Volume 1, 2:56344 (NP-22244(Vol.1))
FOSSIL-FUEL POWER PLANTS/FLUE GAS
Radioactive residual matter. II, 2:55728
FOSSIL-FUEL POWER PLANTS/FUEL CONSUMPTION
Status of coal supply contracts for new electric generating units, 1976-1985, 2:56976 (PB-264769)
FOSSIL-FUEL POWER PLANTS/FUELS
Coal conversion program: Energy supply and Environmental Coordination Act (as amended). Section 2. Draft environmental statement, 2:56961 (PB-265815)
FOSSIL-FUEL POWER PLANTS/GAS TURBINES
High temperature gas turbine engine component materials testing program. Task 1. Quarterly technical progress report No. 7, January 1-March 31, 1977, 2:56250 (FE-1765-30)
FOSSIL-FUEL POWER PLANTS/GASEOUS WASTES
Chalk Point Cooling Tower Project. Volume 2. Summer seasonal test data. Environmental Systems Corporation's comprehensive project final report, October 1, 1975-June 30, 1976, 2:57363 (PPSP-CPCTP-12(Vol.2))
FOSSIL-FUEL POWER PLANTS/GLOBAL ASPECTS
Use of coal in power plants, 2:56978
FOSSIL-FUEL POWER PLANTS/NATURAL DRAFT COOLING TOWERS
Chalk Point Cooling Tower Project. Volume 1. Phase IV, comprehensive field program description. Environmental Systems Corporation's comprehensive project final report, October 1, 1975-June 30, 1976, 2:57362 (PPSP-CPCTP-12(Vol.1))
FOSSIL-FUEL POWER PLANTS/REGULATIONS
Coal conversion program: Energy supply and Environmental Coordination Act (as amended). Section 2. Draft environmental statement, 2:56961 (PB-265815)
FOSSIL-FUEL POWER PLANTS/RELIABILITY
Calculation of the readiness of power plant equipment, 2:56284
FOSSIL-FUEL POWER PLANTS/SITE SELECTION
Recent state laws regulating power facility siting, 2:56748
FOSSIL-FUEL POWER PLANTS/STANDARDIZATION
Gas turbine power plants of large unit capacity in standard construction, 2:56228
FOSSIL-FUEL POWER PLANTS/STEAM TURBINES
Fatigue damage on large components, 2:56692
FOSSIL-FUEL POWER PLANTS/THERMAL EFFLUENTS
Chalk Point Cooling Tower Project. Volume 1. Phase IV, comprehensive field program description. Environmental Systems Corporation's comprehensive project final report, October 1, 1975-June 30, 1976, 2:57362 (PPSP-CPCTP-12(Vol.1))
FOSSIL-FUEL POWER PLANTS/WASTE DISPOSAL
Contamination of groundwater by heavy metals from the land disposal of fly ash. Technical progress report, September 1, 1976-May 31, 1977, 2:57378 (COO-2727-5)
FR-2 REACTOR/NEUTRON RADIOGRAPHY
Neutron radiography at the FR 2 in operation, 2:56763
FRANCE/COAL DEPOSITS
Geography of energy production in France. IV. Natural regions: the inland north and Lorraine, 2:55664
FRANCE/COAL INDUSTRY
Contribution of coal to the energy supply of France, 2:56964
Geography of energy production in France. IV. Natural regions: the inland north and Lorraine, 2:55664
New developments in the French coal plan, 2:56963
FRANCE/ENERGY POLICY
Energy policies of France Great Britain, and Germany compared, 2:56959
FRANCE/ENERGY SUPPLIES
Contribution of coal to the energy supply of France, 2:56964
FRANCE/OIL SHALE DEPOSITS
Geochemical provinces revealed in Toarcian oil shales in the eastern Paris Basin. Analysis of the soluble organic fraction, 2:55830
FRANCE/POWER GENERATION
Contribution of coal to the energy supply of France, 2:56964
Mergers create single French sources for nuclear, fossil, hydro plants, 2:56977
FRANCE/THERMAL SPRINGS
Subsuperficial changes in chemical composition of the thermomineral waters of Vichy basin. Geothermal implications, 2:56193
FRANCO-GERMAN HIGH FLUX REACTOR
See GRENOBLE REACTOR
FREEZERS/ENERGY CONSERVATION
Direct cooling refrigerator-freezers, 2:57017
FREEZERS/ENERGY CONSUMPTION
Direct cooling refrigerator-freezers, 2:57017
FRESH WATER ECOSYSTEMS
See AQUATIC ECOSYSTEMS
FRG-2 REACTOR/REACTOR EXPERIMENTAL FACILITIES
Irradiation and post-irradiation examination techniques for reactor pressure vessel steels at GKSS, 2:56764 (AED-Conf-76-556-013)
FRUITS
(Edible parts of plants only.)
See also PEANUTS
FRUITS/CONTAMINATION
Concentrations of radionuclides and selected stable elements in fruits and vegetables, 2:57381 (CONF-770676-1)
FTR REACTOR
See FFTF REACTOR
FUEL ASSEMBLIES
See also FUEL ELEMENT CLUSTERS
FUEL ASSEMBLIES/DEFORMATION
Combined seismic-LOCA mechanical evaluation for Exxon Nuclear 15 x 15 reload fuel for Westinghouse PWR's, 2:56797 (XN-76-47(NP))
FUEL ASSEMBLIES/DESIGN
Fuel assembly (Patent), 2:56716
Fuel assembly in a reactor (Patent), 2:56715
Fuel assembly in a reactor (Patent), 2:56717
Fuel assembly (Patent; BWR), 2:56404
Fuel assembly in a reactor (Patent; BWR), 2:56401
Fuel assembly (Patent; BWR), 2:56403
Fuel assembly in a reactor (Patent; LMFBR), 2:56577
FUEL ASSEMBLIES/HEAT TRANSFER
Coolant mixing in LMFBR rod bundles and outlet plenum mixing transients. Progress report, December 1, 1976-February 28, 1977, 2:56531 (COO-2245-38)
Transient heat transfer in turbulent flow with time-dependent heat input, 2:56638 (JAERI-M-6597)
FUEL ASSEMBLIES/LIQUID FLOW
Coolant mixing in LMFBR rod bundles and outlet plenum mixing transients. Progress report, December 1, 1976-February 28, 1977, 2:56531 (COO-2245-38)
FUEL ASSEMBLIES/POWER DISTRIBUTION
Method of calculation of detailed power distribution in fuel assemblies (LMFBR), 2:56567
FUEL ASSEMBLIES/STRESSES
Combined seismic-LOCA mechanical evaluation for Exxon Nuclear 15 x 15 reload fuel for Westinghouse PWR's, 2:56797 (XN-76-47(NP))
FUEL ASSEMBLIES/TURBULENT FLOW
Transient heat transfer in turbulent flow with time-dependent heat input, 2:56638 (JAERI-M-6597)
FUEL BUNDLES
See FUEL ELEMENT CLUSTERS
FUEL CANS/CORROSION
In-reactor corrosion behavior of stainless steel in high temperature sodium (LMFBR; SS-316), 2:56523 (CONF-760503-P1)
Influence of sodium on the mechanical properties of fuel element cladding (LMFBR), 2:56519 (CONF-760503-P1)
Influence of dynamic sodium on the creep properties of stabilized austenitic steels (LMFBR), 2:56520 (CONF-760503-P1)
FUEL CANS/ELECTROPOLISHING
Device for continuous electrolytic polishing of rod-shaped work pieces of zirconium alloys (Patent), 2:56712
FUEL CANS/OXIDATION
Behavior of inner surface oxidation of the zircaloy cladding tube in a loss-of-coolant accident (BWR, PWR), 2:56785 (JAERI-M-6602)
FUEL CANS/STRESS ANALYSIS
Effect of liquid sodium thermochemical reactions with stainless steels on mechanical response (LMFBR), 2:56518 (CONF-760503-P1)
FUEL CELLS
See also ACID ELECTROLYTE FUEL CELLS
FUEL CELLS/PERFORMANCE
Electrochemical power sources in ocean engineering, 2:56897 (AED-CONF-76-203-006)
FUEL CHANNELS/COOLING SYSTEMS
Apparatus for cooling a fuel replacing cell in a reactor (Patent; LMFBR), 2:56576

FUEL CHANNELS/DESIGN
Gas-cooled, graphite-moderated nuclear reactor (Patent; AGR), 2:56454
FUEL CHANNELS/HEAT TRANSFER
Laminar heat transfer data with a step-varying wall heat flux, 2:56643
FUEL CHANNELS/LAMINAR FLOW
Laminar heat transfer data with a step-varying wall heat flux, 2:56643
FUEL CONSUMPTION/FORECASTING
Status of coal supply contracts for new electric generating units, 1976-1985, 2:56976 (PB-264769)
FUEL CONSUMPTION/FUEL CONSUMPTION
The costs of cold weather and the conservation of residential heating gas. Staff report (Cost-effective investments for each state), 2:57015 (PB-264759)
FUEL COOLING INSTALLATIONS
See SPENT FUEL STORAGE
FUEL CYCLE
See also FUEL MANAGEMENT
PLUTONIUM RECYCLE
Completing the nuclear fuel cycle, 2:55883
FUEL CYCLE/COMPARATIVE EVALUATIONS
Nuclear fuel cycle: (4) the reactors, 2:56606
FUEL CYCLE/COST BENEFIT ANALYSIS
Benefit-cost analysis in the nuclear fuel cycle, 2:56598
Is plutonium really necessary, 2:55954 (CONF-7605150-1)
FUEL CYCLE/ECONOMICS
Economic computations in the fuel cycle (Allocated costs and discounted cash flow computations), 2:56596
Investigation of conditions of operation of nuclear power plants with water-cooled power reactors, 2:56394
FUEL CYCLE/EDUCATION
Educational aspects of reactor calculations for fuel management, 2:56597
FUEL CYCLE/ENVIRONMENTAL IMPACTS
Light water reactor fuel reprocessing and recycling, 2:55933 (ERDA-77-75)
FUEL CYCLE/PLANNING
HTR near-breeder concept as a means of saving fissile material, 2:56442
FUEL CYCLE/RESEARCH PROGRAMS
Alternative fuel cycle technology progress report for April 1-June 30, 1977 (LWR off-gas treatment; ^{129}I adsorbent and storage development; waste management), 2:55900 (ICP-1122)
FUEL CYCLE/RISK ASSESSMENT
Risk assessment method for nuclear fuel cycle operations, 2:55943
Risk estimation, evaluation, and management, 2:55941
FUEL CYCLE/SAFEGUARDS
Feasibility of denatured LMFBRs, 2:56548
FUEL CYCLE/SYSTEMS ANALYSIS
Fuzzy set theoretic approach to systems analysis, 2:56599
FUEL ECONOMY/BIBLIOGRAPHIES
Fuel economy. Subject bibliography, 2:57024 (PB-265387)
FUEL ELEMENT CLUSTERS/BOILING
Gamma heated subassembly for sodium boiling experiments, 2:56794 (TID-27639)
FUEL ELEMENT CLUSTERS/BOILING DETECTION
Analysis on sodium boiling experiment in FFM bundle 3B, test 4, 2:56817
FUEL ELEMENT CLUSTERS/CRITICAL HEAT FLUX
Critical heat flux: a review of recent publications, 2:56639
FUEL ELEMENT CLUSTERS/DEFORMATION
Coupling of the structural and coolant response in a single core subassembly model, 2:56839
FUEL ELEMENT CLUSTERS/FLOW BLOCKAGE
Analysis on sodium boiling experiment in FFM bundle 3B, test 4, 2:56817
FUEL ELEMENT CLUSTERS/HEAT TRANSFER
On two-phase thermal boundary layer along heated walls (PWR and BWR), 2:56395
FUEL ELEMENT CLUSTERS/PHASE STUDIES
On two-phase thermal boundary layer along heated walls (PWR and BWR), 2:56395
FUEL ELEMENT CLUSTERS/RADIANT HEAT TRANSFER
Thermal radiation effects on subassembly wall failure in fast reactors, 2:56845
FUEL ELEMENT CLUSTERS/TWO-PHASE FLOW
On two-phase thermal boundary layer along heated walls (PWR and BWR), 2:56395
FUEL ELEMENT FAILURE
HTGR fuel failure in the absence of core cooling, 2:56802
FUEL ELEMENT FAILURE/ACOUSTIC MONITORING
Acoustic analysis of TREAT LMFBR safety test R8, 2:56816
FUEL ELEMENT FAILURE/RESEARCH PROGRAMS
Fuel rod mechanics and failure analysis. Eighteenth quarterly report, November-December 1976 and January 1977 (LMFBR), 2:56776 (GEFR-13923-18)
FUEL ELEMENTS
See also FUEL ASSEMBLIES
FUEL CANS
FUEL PINS
FUEL PLATES
FUEL RODS
FUEL SPHERES
NUCLEAR FUELS
SPENT FUEL ELEMENTS
Behavior of irradiated fuel rods during film boiling operation, 2:56808
Effects of fill-gas composition and eccentric gap geometry on gap conductance of UO_2 fuel rods, 2:56708
FUEL ELEMENTS/BURNUP
Elaboration of methods for burn-up determinations of fast reactor fuel, 2:56570
FUEL ELEMENTS/DESIGN
Fuel element for heavy water moderated nuclear reactors (Patent), 2:56467
Nuclear fuel element (Patent), 2:56719
Spherical fuel element for high temperature reactors, 2:56452
FUEL ELEMENTS/DESTRUCTIVE TESTING
Examination of fast reactor fuels, FBR analytical quality assurance standards and methods, and analytical methods development: irradiation tests. Progress report, January 1-March 31, 1977 (UO_2; PuO_2), 2:56539 (LA-6808-PR)
FUEL ELEMENTS/FISSION PRODUCT RELEASE
Postirradiation examinations of the BG-9 element (GCFR type reactors), 2:56475 (ANL-8067)
Release of fission gas from high-burnup fuel during transient heating, 2:56372
FUEL ELEMENTS/HEAT TRANSFER
Effect of variable thermal conductivity in thermal-hydraulic calculations, 2:56875
FUEL ELEMENTS/NONDESTRUCTIVE TESTING
Examination of fast reactor fuels, FBR analytical quality assurance standards and methods, and analytical methods development: irradiation tests. Progress report, January 1-March 31, 1977 (UO_2; PuO_2), 2:56539 (LA-6808-PR)
FUEL ELEMENTS/PERFORMANCE
CANDU fuel: power ramp performance criteria, 2:56460
FRAP-S2: a computer code for the steady state analysis of oxide fuel rods, 2:56369 (TREE-NUREG-1107)
Operational experience with Westinghouse cores (up to December 31, 1976), 2:56409 (WCAP-8183(Rev.6))
FUEL ELEMENTS/PERFORMANCE TESTING
Development of plutonium fuels in PNC, 2:56710
Postirradiation examinations of the BG-9 element (GCFR type reactors), 2:56475 (ANL-8067)
FUEL ELEMENTS/QUALITY ASSURANCE
Examination of fast reactor fuels, FBR analytical quality assurance standards and methods, and analytical methods development: irradiation tests. Progress report, January 1-March 31, 1977 (UO_2; PuO_2), 2:56539 (LA-6808-PR)
FUEL ELEMENTS/STRESS ANALYSIS
Simplified method of computing clad and fuel strain and stress during irradiation (KRESS code), 2:56560
FUEL FABRICATION PLANTS/CHEMICAL EFFLUENTS
Cost of controlling inorganic chemical releases from LWR fuel fabrication plants, 2:55936
FUEL FABRICATION PLANTS/NUCLEAR MATERIALS MANAGEMENT
Determination of optimal composition of nondeliverable fabrication plant fuel material, 2:55873
Uranium accountability for ATR fuel fabrication. Part I. A description of the existing system, 2:55965 (TREE-1145)
FUEL FEEDING SYSTEMS/DRYING
Development of coal-feeding systems at the Morgantown Energy Research Center (62 refs), 2:55713 (MERC/RI-77/2)
FUEL FEEDING SYSTEMS/PERFORMANCE TESTING
Coal pressurization and feeding use of a lock hopper system, 2:55563 (CONF-770655-1)
FUEL FEEDING SYSTEMS/RESEARCH PROGRAMS
Development of coal-feeding systems at the Morgantown Energy Research Center (62 refs), 2:55713 (MERC/RI-77/2)
FUEL FEEDING SYSTEMS/VALVES
Stuffing box test procedure, 2:55581 (FE-2356-20)
FUEL GAS
See also HIGH BTU GAS
LOW BTU GAS
FUEL GAS/CALORIFIC VALUE
Problems solved and problems not solved in UCG, 2:55560 (CONF-770510-6)
FUEL GAS/CONSUMPTION RATES
The costs of cold weather and the conservation of residential heating gas. Staff report (Cost-effective investments for each state), 2:57015 (PB-264759)

FUEL GAS/DEW POINT
Dew points of hot gases from coal gasification processes. Quarterly report, June 1-August 31, 1976 (4 refs), 2:55571 (FE-2046-1)
Dew points of hot gases from coal gasification processes. Quarterly report, September 1-November 30, 1976 (4 refs), 2:55572 (FE-2046-2)
FUEL GAS/EQUATIONS OF STATE
Dew points of hot gases from coal gasification processes. Quarterly report, June 1-August 31, 1976 (4 refs), 2:55571 (FE-2046-1)
FUEL GAS/SYNTHESIS
Production of clean synthesis or fuel gas (Patent; from liquid hydrocarbonaceous fuels such as petroleum or its products, coal products, shale oils, or slurry of solid carbonaceous fuel), 2:55988
Production of clean synthesis or fuel gas (Patent; from liquid hydrocarbonaceous fuels such as petroleum or its products, coal products, shale oils, or slurry of solid carbonaceous fuel), 2:55989
Production of clean synthesis or fuel gas (Patent; by-product steam), 2:55990
Pyrolysis process for converting refuse to fuel gas (Patent; optimization of Purox Pyrolysis Process), 2:55993
FUEL INJECTION SYSTEMS/DESIGN
Effect of design parameters of a fuel pump section on the injection process and the diesel engine working process, 2:57064
FUEL MANAGEMENT
Code to assist in teaching nuclear fuel management, 2:56622
Interface between fuel management and nuclear fuel accounting, 2:56602
Investigation of conditions of operation of nuclear power plants with water-cooled power reactors, 2:56394
Resource utilization of symbiotic HTGR systems, 2:56434
FUEL MANAGEMENT/OPTIMIZATION
Optimal in-core fuel management for boiling water reactors, 2:56371
FUEL OILS
See also RESIDUAL FUELS
FUEL OILS/ATOMIZATION
Experimental investigation of residual fuel oil atomization by water injectors, 2:57320
FUEL OILS/COMBUSTION
High temperature coal and slurry combustor according to a one-dimensional flow model, 2:55722 (CONF-770530-2)
Investigation of the effect of nitrogen-containing fuel additives on the formation of nitrogen oxides, 2:55805
FUEL OILS/COMBUSTION PRODUCTS
Lowering of pollutant content in emissions from fuel combustion in boilers of middle capacity, 2:55791
FUEL OILS/COMBUSTION PROPERTIES
Investigation of visible and ultraviolet emission from fuel oil flames on an industrial scale, 2:57318
FUEL OILS/FLAMES
Investigation of visible and ultraviolet emission from fuel oil flames on an industrial scale, 2:57318
FUEL OILS/PRODUCTION
Engineering evaluations of coal conversion processes. Part I. Hydrocarbonization and Synthoil: information base, process selection, and preliminary evaluation of alternatives, 2:55617 (ORNL/TM-5034)
FUEL PARTICLES
See also COATED FUEL PARTICLES
FUEL PARTICLES/CAVITATION
Particle cavitation during hydrogen reduction of mixed-oxide fuel, 2:55871
FUEL PARTICLES/SURFACE COATING
Method and fluidized bed furnace for coating nuclear fuel particles and others (Patent), 2:56714
FUEL PELLETS/CHEMICAL ANALYSIS
Fuels characterization in LMFBR, 2:56544
FUEL PELLETS/CRACKS
Effect of pellet cracking on light water reactor fuel temperatures, 2:56392
FUEL PELLETS/DESIGN
Nuclear fuel pellets (Patent), 2:56718
FUEL PELLETS/FABRICATION
Fuels characterization in LMFBR, 2:56544
Method and device for the fabrication of nuclear fuel compacts (Patent), 2:55870
FUEL PELLETS/SINTERING
Ammonia as a sintering aid for UO_2, 2:55875
FUEL PELLETS/STRESSES
Effect of pellet density and axial restraint on failure threshold, 2:56854
FUEL PELLETS/THERMAL CONDUCTIVITY
Effect of pellet cracking on light water reactor fuel temperatures, 2:56392
FUEL PINS/CORROSION
Influence of LMFBR fuel pin temperature profiles on corrosion rate (SS-316), 2:56524 (CONF-760503-P1)
FUEL PINS/DEFORMATION
BOBL code. Experimental verification of the hydraulic model, including effects of pin bowing and grids (LMFBR), 2:56536 (ECN-9)
FUEL PINS/DESIGN
Breeding performance optimization of helium-bonded carbide fuel in 1500-MW(e) LMFBRs, 2:56549
FUEL PINS/SIMULATORS
Development and testing of high-performance fuel pin simulators for boiling experiments in liquid metal flow (LMFBR), 2:56500 (CONF-760503-P1)
FUEL PLATES/BENDING
Flow-induced bending of rectangular plates, 2:56758
FUEL POOLS/DESIGN
B and W-designed close-spaced fuel storage racks, 2:56412
Westinghouse high-density spent fuel rack design, 2:56411
FUEL POOLS/SEISMIC EFFECTS
Comparing structural loads in large pools evaluated with the LUSH code and current design methods, 2:56796 (UCRL-79277)
FUEL REPROCESSING PLANTS
See also WEST VALLEY PROCESSING PLANT
FUEL REPROCESSING PLANTS/CHEMICAL EFFLUENTS
Anticipated chemical emissions from a large fuel reprocessing plant, 2:55937
Toxicity of some of the organic emissions identified in the effluents from reprocessing nuclear fuel, 2:55938
FUEL REPROCESSING PLANTS/CRITICALITY
Reactivity measurements under conditions typical to fuel element dissolution, 2:55886
FUEL REPROCESSING PLANTS/ENVIRONMENTAL IMPACTS
Anticipated chemical emissions from a large fuel reprocessing plant, 2:55937
FUEL REPROCESSING PLANTS/RISK ASSESSMENT
Risk comparison of alternatives of the back end of the fuel cycle at a pre-project stage, 2:55946
FUEL RODS/DESIGN
Fuel rod in a reactor (Patent; Reactivity compensation of fuel burnup), 2:56720
FUEL RODS/FABRICATION
Apparatus for mixing particulate substances using a fluid under pressure (Patent), 2:56713
FUEL RODS/HEAT TRANSFER
Temperature increase in the contact of elements with internal heating at high heat flux densities, 2:56647
FUEL SLURRIES/DENSITY
Measurements of coal slurry concentration in haulage pipelines by nuclear techniques, 2:55714
FUEL SPHERES
(Pebble bed reactor fuel elements.)
FUEL SPHERES/DESIGN
Test or measuring sphere for nuclear reactors with spherical fuel elements (Patent), 2:56453
FUEL SYSTEMS
See also FUEL FEEDING SYSTEMS
FUEL INJECTION SYSTEMS
FUEL SYSTEMS/CONTROL SYSTEMS
Air-fuel ratio control system for use with internal combustion engine (Patent), 2:57084
FUEL-CLADDING INTERACTIONS
Effect of pellet density and axial restraint on failure threshold, 2:56854
FUEL-COOLANT INTERACTIONS
Correlation for the Leidenfrost temperature for spherical particles and its application to FCI analysis, 2:56857
Mechanisms of vapor explosions. Technical progress report, October 1976-March 1977 (LMFBR), 2:56532 (COO-2512-10)
Radiological assessment models. Tenth quarterly report, December 1976-February 1977, 2:56777 (GEFR-14034-10)
FUEL-COOLANT INTERACTIONS/MATHEMATICAL MODELS
Molten fuel-coolant interaction during hypothetical accidents in light water reactors, 2:56876
FUELS
See also AUTOMOTIVE FUELS
FOSSIL FUELS
FUEL GAS
HYDROGEN FUELS
NUCLEAR FUELS
SOLVENT-REFINED COAL
SYNTHETIC FUELS
THERMONUCLEAR FUELS

FUELS/ADDITIVES
Study of chemical behavior of dispersant additives on metal surfaces: reaction of amide functions on aluminum oxide, 2:55774
FUELS/BIBLIOGRAPHIES
Energy, 2:57834
FUELS/COMBUSTION
Investigation of stability and breakup of particles of a material during fusion in a gas suspension, 2:57321
FUELS/COMBUSTION PROPERTIES
Numerical evaluation of thermodynamic equilibrium states for gas mixtures, 2:57245
FUELS/PRODUCTION
Radiolytic production of chemical fuels in fusion reactor systems, 2:57786 (COO-3028-28)
FUELS/THERMODYNAMIC PROPERTIES
Numerical evaluation of thermodynamic equilibrium states for gas mixtures, 2:57245
FUGEN ATR
See JATR REACTOR
FUMAROLES/GEOCHEMICAL SURVEYS
Heat discharge measurement and geophysical prospecting at Nigorikawa basin, northern part of Komagatake, 2:56183
FUMAROLES/GEOPHYSICAL SURVEYS
Heat discharge measurement and geophysical prospecting at Nigorikawa basin, northern part of Komagatake, 2:56183
FUMAROLES/HEAT TRANSFER
Heat discharge measurement and geophysical prospecting at Nigorikawa basin, northern part of Komagatake, 2:56183
FUMAROLES/TEMPERATURE MEASUREMENT
Ground temperature surveys and thermal discharge measurements at Ibusuki and its surrounding geothermal areas, 2:56185
FUMAROLIC FLUIDS/CHEMICAL COMPOSITION
Observation of a newly appeared active fumarole at Owakudani, Hakone volcano, 2:56180
FUMAROLIC FLUIDS/TEMPERATURE MEASUREMENT
Observation of a newly appeared active fumarole at Owakudani, Hakone volcano, 2:56180
FUMES
See AEROSOLS
FUNCTIONALS/OPTIMIZATION
Davidon's optimally conditioned algorithms for unconstrained optimization, 2:57807 (ANL-AMD-TM-283(Rev.))
FURNACES
See also BLAST FURNACES
GAS GENERATORS
Improved gas distributor for coating HTGR fuel particles, 2:55872
FURNACES/DESIGN
European waste-to-energy systems. An overview, 2:57022 (CONS/2103-6)
FURNACES/EFFICIENCY
Preparation of liquid fuels by gas atomization, 2:57317
FURNACES/FUEL CONSUMPTION
Heating bell furnaces with natural gas, 2:57041
FURNACES/MODIFICATIONS
Heating bell furnaces with natural gas, 2:57041
FURNACES/POLLUTION CONTROL EQUIPMENT
Method of starting a combustion system utilizing a catalyst (Patent), 2:57086
FURNACES/WASTE HEAT
Heat recuperator: improved heat transfer efficiency, 2:57044
Thermal operation of double-bath steel-smelting furnaces, 2:57042
FUSED SALTS
See MOLTEN SALTS
FUSION REACTORS
See THERMONUCLEAR REACTORS

G

GALLIUM ARSENIDES/PHYSICAL RADIATION EFFECTS
Influence of temperature on the accumulation and properties of radiation damage in gallium arsenide under electron irradiation (28 MeV, 20 to 300°C), 2:57188
GAMMA CAMERAS/PERFORMANCE
Performance characteristics of the large field scintillation gamma cameras, 2:57422
GAS APPLIANCES
See also AIR CONDITIONERS
FREEZERS
REFRIGERATORS
WATER HEATERS
GAS APPLIANCES/SAFETY
Control of the level of NO/sub x/ in the indoor environment, 2:57459 (CONF-770557-2)
GAS COMPRESSORS/TURBINE BLADES
Experimental investigation of the effect of frequency nonuniformity on the level of resonance vibrations of rotor blades, 2:56326
GAS COOLANTS
See GASES
GAS COOLED FAST BREEDER REACTORS
See GCFR TYPE REACTORS
GAS COOLED REACTORS
See also AGR TYPE REACTORS
GCFR TYPE REACTORS
HTGR TYPE REACTORS
GAS COOLED REACTORS/GAS TURBINES
Mathematical model to analyze the effect of properties of the working media on principal technical and economic indices of nuclear gas turbine plants, 2:56450
GAS ENGINES
See INTERNAL COMBUSTION ENGINES
GAS GENERATORS/DESIGN
Apparatus for generating high-pressure gas (Patent), 2:57077
GAS LASERS
See also CARBON DIOXIDE LASERS
CARBON MONOXIDE LASERS
HELIUM-NEON LASERS
GAS LASERS/ELECTRIC DISCHARGES
Discharge studies of the Ne-Cu laser, 2:57287
GAS LASERS/FIELD EMISSION
Investigation of coupling of field emission cold cathode guns for gas lasers. Final technical report, 2:57283 (AD-A-037734)
GAS LASERS/FREQUENCY CONTROL
Power resonances of a two-mode ring laser, 2:57290
GAS LASERS/FREQUENCY SELECTION
Frequency selection in gas lasers by means of the Faraday effect in the active medium, 2:57288
GAS LASERS/MATERIALS RECOVERY
Requirements for optimum chemical recoverability in photolytically pumped atomic iodine lasers, 2:57285 (SAND-76-9310)
GAS LASERS/NUCLEAR PUMPING
Laser-fusion concept using D-D-T pellets with the DNP laser feedback system, 2:57767 (COO-2007-82)
GAS LASERS/PERFORMANCE
Performance characteristics of the Sandia atomic iodine laser (SAIL-1), 2:57284 (SAND-76-9300)
GAS TURBINES/COMPARATIVE EVALUATIONS
Improving the efficiency of low-capacity gas turbine engines, 2:56324
GAS TURBINES/COMPRESSED AIR ENERGY STORAGE
Brown Boveri air-storage gas turbines, 2:56261
GAS TURBINES/COMPRESSORS
Development of brown boveri gas turbine compressors, 2:56264
Investigation of surge protection of compressors of gas turbine power plants, 2:56335
GAS TURBINES/CONTROL EQUIPMENT
Characteristics of a control disk throttle with a limited angle of swivel, 2:56319
GAS TURBINES/CONTROL SYSTEMS
Fiat HI-control system for Fiat gas turbines, 2:56278
Investigation of gas turbine plant control systems with two controllers acting on one actuator, 2:56338
GAS TURBINES/COOLING
External gas turbine engine cooling for clearance control (Patent), 2:57078
GAS TURBINES/CORROSION
High temperature turbine technology program. Phase I. Program and system definition. Topical report: fuels cleanup and turbine tolerance, 2:56245 (FE-2290-27)
GAS TURBINES/CORROSION PROTECTION
Corrosion and its prevention in modern stationary gas turbines, 2:56262
GAS TURBINES/DESIGN
Boosting of power gas turbine installations by water injection into the high pressure tract, 2:56332
Brown Boveri air-storage gas turbines, 2:56261
External gas turbine engine cooling for clearance control (Patent), 2:57078
Nuclear gas turbine power plant activities in the United States, 2:56447
Optimization of the initial gas temperature of peaking gas turbine power plants, 2:56271
GAS TURBINES/EFFICIENCY
Boosting of power gas turbine installations by water injection into the high pressure tract, 2:56332
Improving the efficiency of low-capacity gas turbine engines, 2:56324
GAS TURBINES/EROSION
High temperature turbine technology program. Phase I. Program and system definition. Topical report: fuels cleanup and turbine tolerance, 2:56245 (FE-2290-27)

GAS TURBINES/EXHAUST GASES
Exhaust gas emissions of Brown Boveri gas turbines, 2:56347
Flow in exhaust gas diffusers, 2:56265
GAS TURBINES/FILM COOLING
Film cooling with injection through slots, 2:56311
GAS TURBINES/FUEL ECONOMY
Reduction of fuel consumption of a two-shaft gas turbine engine in idle run, 2:57326
GAS TURBINES/FUEL SYSTEMS
Fluid flow control valve for gas turbine engine fuel control system (Patent), 2:57076
GAS TURBINES/MECHANICAL VIBRATIONS
Techniques of vibration analysis applied to gas turbines, 2:56293
GAS TURBINES/OPERATION
Direct electric gas heating for gas turbines, 2:56279
Optimization of the initial gas temperature of peaking gas turbine power plants, 2:56271
GAS TURBINES/PERFORMANCE
Experience with a type 9 gas turbine in iran, 2:56260
Experience with gas turbines fired with blast-furnace gas, 2:56267
Rolls-Royce Avon in the Middle East, 2:55764
GAS TURBINES/PERFORMANCE TESTING
Method of measurement for thermal tests of the GT-100-750-2 LMZ (Leningrad Metal Works) gas turbine power plant, 2:56333
Thermal tests of a GT-35 gas turbine unit operating in a steam and gas turbine power plant with a high-pressure boiler, 2:56288
GAS TURBINES/POLLUTION CONTROL EQUIPMENT
Method of starting a combustion system utilizing a catalyst (Patent), 2:57086
GAS TURBINES/RESEARCH PROGRAMS
Gas turbine HTGR program. Quarterly progress report for the period ending March 31, 1977, 2:56429 (GA-A-14381)
High temperature gas turbine engine component materials testing program. Task 1. Quarterly technical progress report No. 7, January 1-March 31, 1977, 2:56250 (FE-1765-30)
High temperature turbine technology program. Phase I. Program and system definition. Topical report: fuels cleanup and turbine tolerance, 2:56245 (FE-2290-27)
GAS TURBINES/REVIEWS
Problems and prospects of development of gas turbine power plants, 2:56276
GAS TURBINES/SERVICE LIFE
Rolls-Royce Avon in the Middle East, 2:55764
GAS TURBINES/TURBINE BLADES
Cooling of gas turbines blades, 2:56263
Measuring vibration on turbine blades by optical means, 2:56266
Pressure loss coefficient of impingement cooled leading edge system of a turbine blade, 2:56308
Rational ways of increasing unit capacity of power gas turbine installations constructed according to a simple thermal diagram, 2:56313
Synthesis of optimal design of variable-section rotor blades, 2:56320
GAS TURBINES/USES
Typical applications of the gas turbine, 2:56259
GASEOUS WASTES
See also EXHAUST GASES
FLUE GAS
GASEOUS WASTES/DATA COMPILATION
Chalk Point Cooling Tower Project. Volume 2. Summer seasonal test data. Environmental Systems Corporation's comprehensive project final report, October 1, 1975-June 30, 1976 (Fossil-fuel power plant), 2:57363 (PPSP-CPCTP-12(Vol.2))
GASEOUS WASTES/ENVIRONMENTAL TRANSPORT
Chalk Point Cooling Tower Project. Volume 2. Summer seasonal test data. Environmental Systems Corporation's comprehensive project final report, October 1, 1975-June 30, 1976 (Fossil-fuel power plant), 2:57363 (PPSP-CPCTP-12(Vol.2))
GASEOUS WASTES/WASTE DISPOSAL
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-1. Environmental considerations affecting the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55605 (FE-1752-16)
GASES
See also AIR
NATURAL GAS
GASES/CHEMICAL REACTIONS
Application of ion cyclotron resonance spectroscopy, photoionization mass spectrometry and photoelectron spectroscopy to study the properties and reactions of ions in gases. Technical progress report, April 1, 1976-January 31, 1977, 2:57210 (CALT-767P8-7)
GASES/COMBUSTION
Linearized nonequilibrium flow of a combustible mixture during interaction of two supersonic gas streams, 2:57246
GASES/COMBUSTION PROPERTIES
Numerical evaluation of thermodynamic equilibrium states for gas mixtures, 2:57245
GASES/ELECTRON COLLISIONS
Measurement of absolute collision cross sections of electrons elastically scattered by gases (Reviews), 2:57520
GASES/PHOTON TRANSPORT
Compton-radiation gas dynamics, 2:57620 (UCRL-Trans-11236)
GASES/SUPERSONIC FLOW
Linearized nonequilibrium flow of a combustible mixture during interaction of two supersonic gas streams, 2:57246
GASES/THERMODYNAMIC PROPERTIES
Numerical evaluation of thermodynamic equilibrium states for gas mixtures, 2:57245
GAS-INSULATED CABLES/PERFORMANCE TESTING
Design, application and testing of SF_6 insulated cable, 2:56359
GASKETS/COMPRESSIBILITY
Compressibility and compliance of spiral wound gaskets (CANDU), 2:56464
GASOLINE
See also MOBIL M-GASOLINE PROCESS
GASOLINE/ADDITIVES
Manganese containing fuels (Patent), 2:57087
GASOLINE/MARKET
Changes in the petrol retailing movement (Self-Service Gasoline Stations), 2:55787
National outlets survey for the year-end 1976, 2:55788
Petroleum market shares. Report on sales of retail gasoline. Monthly report, 2:55782 (NTISUB/B-125-76/011)
GASOLINE/PRODUCTION
Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels. Quarterly report, December 1976-February 1977, 2:55609 (FE-1800-12)
GASOLINE/SYNTHESIS
Fluid bed process studies on selective conversion of methanol to high octane gasoline. Monthly report for May 1977, 2:55983 (FE-2490-8)
GASTEROPODS
See MOLLUSCS
GCFR TYPE REACTORS/DESIGN
Gas-cooled breeder reactor making progress in Europe, 2:56551
GCFR TYPE REACTORS/EXCURSIONS
Coupled fission gas release and molten fuel motion model for slow overpower transients, 2:56855
GCFR TYPE REACTORS/FUEL ELEMENT FAILURE
Thermal radiation effects on subassembly wall failure in fast reactors, 2:56845
GCFR TYPE REACTORS/FUEL ELEMENTS
Postirradiation examinations of the BG-9 element, 2:56475 (ANL-8067)
GCFR TYPE REACTORS/REACTOR ACCIDENTS
Thermal radiation effects on subassembly wall failure in fast reactors, 2:56845
GCFR TYPE REACTORS/WORKING FLUIDS
Efficacy of the working media of nuclear power plants with gas-cooled fast reactors and low-temperature utilization of heat to obtain fresh water, 2:56563
GEESTHACHT-2 RESEARCH REACTOR
See FRG-2 REACTOR
GE(LI) DETECTORS
See LI-DRIFTED GE DETECTORS
GENERATORS (ELECTRIC)
See ELECTRIC GENERATORS
GENERATORS (STEAM)
See STEAM GENERATORS
GENETICS
Studies in developmental immunogenetics. Annual progress report, 2:57406 (CALT-767P6-X12)
GEOLOGIC STRUCTURES/GEOTHERMAL GRADIENTS
Geothermal conditions of subsalt rocks of the eastern part of pre-caspian depression and their oil and gas potential, 2:55751
GEOLOGIC STRUCTURES/RADIONUCLIDE MIGRATION
Flow of radioactive gases through ground layers, 2:56750 (IKE-6-104)
GEOMAGNETIC STORMS
See MAGNETIC STORMS
GEOPRESSURED SYSTEMS/GEOTHERMAL POWER PLANTS
Analysis of electricity production costs from the geopressured geothermal resource, 2:56194 (BNWL-2192)
GEOPRESSURED SYSTEMS/POWER POTENTIAL
Analysis of electricity production costs from the geopressured geothermal resource, 2:56194 (BNWL-2192)
GEOTHERMAL ENERGY/DATA ACQUISITION
Standards for multilateral and world wide exchange of geothermal data, 2:56169 (LBL-6305)

GEOTHERMAL ENERGY/ENERGY SOURCE DEVELOPMENT
More about geothermal steam or the hottest energy prospect ever, 2:56172
GEOTHERMAL ENERGY/FEASIBILITY STUDIES
Report on the Western Energy Expansion Study, 2:56986 (NP-22295)
GEOTHERMAL ENERGY/FINANCING
More about geothermal steam or the hottest energy prospect ever, 2:56172
GEOTHERMAL ENERGY/REVIEWS
Geothermal heat, 2:56173
GEOTHERMAL ENERGY/TOTAL ENERGY SYSTEMS
Utilization of geothermal energy other than power generation, 2:56205
GEOTHERMAL ENERGY/USES
Utilization of geothermal energy other than power generation, 2:56205
GEOTHERMAL ENERGY CONVERSION/COST
Analysis of electricity production costs from the geopressured geothermal resource, 2:56194 (BNWL-2192)
GEOTHERMAL ENERGY CONVERSION/ECONOMICS
Geothermal energy as a source of electric power. Thermodynamic and economic design criteria (Book), 2:56198
GEOTHERMAL ENERGY CONVERSION/THERMODYNAMIC CYCLES
Geothermal energy as a source of electric power. Thermodynamic and economic design criteria (Book), 2:56198
GEOTHERMAL EXPLORATION/INFRARED SURVEYS
Method for identifying anomalous terrestrial heat flows (Patent), 2:56181
GEOTHERMAL FIELDS
See also CERRO PRIETO GEOTHERMAL FIELD
MATSUKAWA GEOTHERMAL FIELD
GEOTHERMAL FIELDS/ENVIRONMENTAL IMPACTS
Predicting the effect of geothermal emissions on the temperature and relative humidity in the Imperial Valley of California, 2:56197
GEOTHERMAL FIELDS/HEAT TRANSFER
Ground temperature surveys and thermal discharge measurements at Ibusuki and its surrounding geothermal areas, 2:56185
Natural convection in porous media with heat generation, 2:56801
Total heat discharge from northern Azuma geothermal area, 2:56184
GEOTHERMAL FLUIDS
See also FUMAROLIC FLUIDS
GEOTHERMAL FLUIDS/CORROSIVE EFFECTS
Geothermal power plants and their material trends, 2:56202
Nitinol self-descaling surface for geothermal scale control, 2:56201 (LBL-6324)
GEOTHERMAL FLUIDS/ENVIRONMENTAL IMPACTS
Radon emanation in geothermal steam, 2:56196
GEOTHERMAL FLUIDS/FLASHING
Method of removing dissolved non-condensibles from geothermal brines (Patent), 2:56199
GEOTHERMAL POWER PLANTS/CORROSION PROTECTION
Nitinol self-descaling surface for geothermal scale control, 2:56201 (LBL-6324)
GEOTHERMAL POWER PLANTS/COST
Analysis of electricity production costs from the geopressured geothermal resource, 2:56194 (BNWL-2192)
GEOTHERMAL POWER PLANTS/OPTIMIZATION
Analysis of electricity production costs from the geopressured geothermal resource, 2:56194 (BNWL-2192)
GEOTHERMAL WELLS/PUMPS
Geothermal energy control system and method (Patent; downhole turbine-driven pump system), 2:56203
GEOTHERMOMETRY/ALUMINIUM SILICATES
Temperature and pressure of the Ryoke gneisses estimated by garnet-cordierite geothermometer, 2:56214
GEOTHERMOMETRY/GARNETS
Temperature and pressure of the Ryoke gneisses estimated by garnet-cordierite geothermometer, 2:56214
GEOTHERMOMETRY/MAGNESIUM SILICATES
Temperature and pressure of the Ryoke gneisses estimated by garnet-cordierite geothermometer, 2:56214
GERMAN DEMOCRATIC REPUBLIC/DISTRICT HEATING
Technical development of district heating in the German Democratic Republic, 2:56342
GERMAN FEDERAL REPUBLIC/COAL MINES
Modern mine ventilation installations, 2:55704
Shield support practice in German coal mining (5 refs), 2:55691
Trolley-wire-operated underground locomotive with manual and remote control, including fully automatic control and speed regulation, 2:55706
GERMAN FEDERAL REPUBLIC/CO-GENERATION
European waste-to-energy systems. Case study of Munich: Munich North IA and IB, Munich North II, Munich South IV and V, 2:56981 (CONS/2103-4)
GERMAN FEDERAL REPUBLIC/DISTRICT HEATING
Economic benefits of district heating, 2:56910
European waste-to-energy systems. Case study of Munich: Munich North IA and IB, Munich North II, Munich South IV and V, 2:56981 (CONS/2103-4)
GERMAN FEDERAL REPUBLIC/ENERGY CONSUMPTION
Primary energy consumption of the Federal Republic of Germany in 1976, 2:56983
GERMAN FEDERAL REPUBLIC/ENERGY DEMAND
Status report at the end of the concept phase, 1 August 1975-30 November 1976 (Nuclear coal gasification), 2:55590 (ERDA-tr-296)
Ultimate energy requirements for small consumers, 2:56953
GERMAN FEDERAL REPUBLIC/ENERGY POLICY
Energy policies of France Great Britain, and Germany compared, 2:56959
GERMAN FEDERAL REPUBLIC/ENERGY SUPPLIES
Primary energy consumption of the Federal Republic of Germany in 1976, 2:56983
GERMAN FEDERAL REPUBLIC/NATIONAL DEFENSE
Peaceful utilization of nuclear energy: effects on the policy of security in the Federal Republic, 2:56882 (ERDA-tr-273)
GERMAN FEDERAL REPUBLIC/NUCLEAR POWER PLANTS
Data for the evaluation of the properties of sites for nuclear power plants in consideration of reactor safety and radiation protection, 2:56749 (NP-tr-1974)
Peaceful utilization of nuclear energy: effects on the policy of security in the Federal Republic, 2:56882 (ERDA-tr-273)
GERMAN FEDERAL REPUBLIC/POWER GENERATION
Primary energy consumption of the Federal Republic of Germany in 1976, 2:56983
GERMAN FEDERAL REPUBLIC/RADIOACTIVE WASTE MANAGEMENT
Risk analysis of radioactive waste management systems in Germany, 2:55944
GERMAN FEDERAL REPUBLIC/SURFACE MINING
Surface mining of brown coal, its environmental influence and future prospects: illustrated by the example of the Rhenish brown coal mining industry, 2:55669 (AED-CONF-76-417-001)
GERMAN FEDERAL REPUBLIC/WASTE PROCESSING
European waste-to-energy systems. Case study of Munich: Munich North IA and IB, Munich North II, Munich South IV and V, 2:56981 (CONS/2103-4)
GERMANIUM/PHYSICAL RADIATION EFFECTS
Influence of irradiation on copper- and antimony-doped germanium (Electrons), 2:57152
Number of Frenkel defects in germanium irradiated with high-energy gamma rays, 2:57153
GERMANIUM ALLOYS/FABRICATION
Studies of design parameters in the fabrication of Nb-Al-Ge superconductors by the powder metallurgy infiltration method, 2:57091 (LBL-5772)
GERMANIUM ALLOYS/GRAIN GROWTH
Kinetics of formation of the A-15 phase in the Nb-Al-Ge system, 2:57105 (LBL-6266)
GERMANIUM ALLOYS/SUPERCONDUCTIVITY
Kinetics of formation of the A-15 phase in the Nb-Al-Ge system, 2:57105 (LBL-6266)
Studies of design parameters in the fabrication of Nb-Al-Ge superconductors by the powder metallurgy infiltration method, 2:57091 (LBL-5772)
GERMANY (DEMOCRATIC REPUBLIC)
See GERMAN DEMOCRATIC REPUBLIC
GERMANY (FEDERAL REPUBLIC)
See GERMAN FEDERAL REPUBLIC
GEYSERS GEOTHERMAL FIELD/BRINES
Geothermal power plants and their material trends, 2:56202
GEYSERS GEOTHERMAL FIELD/ENVIRONMENTAL EFFECTS
Effects of geothermal energy utilization on stream biota and water quality at The Geysers, California. Final report, 2:56195 (NP-21722)
GEYSERS GEOTHERMAL FIELD/GEOTHERMAL FLUIDS
Geothermal power plants and their material trends, 2:56202
GEYSERS GEOTHERMAL FIELD/WATER QUALITY
Effects of geothermal energy utilization on stream biota and water quality at The Geysers, California. Final report, 2:56195 (NP-21722)
GIANT RESONANCE/ISOSPIN
Isospin shift of the energy of the giant resonance, 2:57612
GLASS/ABSORPTION SPECTRA
Optical properties of trivalent chromium in silicate glasses: A study of energy levels in the crossing region, 2:57179
GLASS/WEATHERING
Real time outdoor exposure testing of solar cell modules and component materials, 2:56042 (ERDA/NASA/1022-77/10)

GLAUBER THEORY/ATOM COLLISIONS
Glauber and Glauber-related methods in atomic physics (Review), 2:57547
GLIOBLASTOMAS
See NEOPLASMS
GLYCOSYL HYDROLASES/BIOCHEMISTRY
Mechanisms of innate immunity: cytoplasmic granules of polymorphonuclear neutrophilic granulocytes, antimicrobial action, translocation, role, and fate in antimicrobial phagocytosis. Progress report, March 1976-June 30, 1977, 2:57413 (ORO-3628-11)
GLYCOSYL HYDROLASES/CHEMICAL ANALYSIS
Mechanisms of innate immunity: cytoplasmic granules of polymorphonuclear neutrophilic granulocytes, antimicrobial action, translocation, role, and fate in antimicrobial phagocytosis. Progress report, March 1976-June 30, 1977, 2:57413 (ORO-3628-11)
GOLD/DEPOSITION
Coatings application for fusion research, 2:57099
GOLD/ION-MOLECULE COLLISIONS
Experimental evidence for anisotropy of non-characteristic x-rays (Review, cross sections), 2:57542
GOLD 197 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
GOLD 198/ENVIRONMENTAL TRANSPORT
Finite element models for sediment and contaminant transport in surface waters. Transport of sediments and radionuclides in the Clinch River (^{137}Cs, ^{90}Sr, ^{198}Au), 2:57398 (BNWL-2227)
GOLD ORES/RESERVES
Canadian reserves of seven metals, 2:56933
GONIOMETERS/DESIGN
Simple goniometer for precise grinding and electropolishing of single crystal surfaces, 2:57343
GRANITES/STRESS ANALYSIS
Empirical relation for dilatant behavior in brittle rocks, 2:57474 (UCRL-79011)
GRANITES/TENSILE PROPERTIES
Empirical relation for dilatant behavior in brittle rocks, 2:57474 (UCRL-79011)
GRANODIORITES/STRESS ANALYSIS
Empirical relation for dilatant behavior in brittle rocks, 2:57474 (UCRL-79011)
GRANODIORITES/TENSILE PROPERTIES
Empirical relation for dilatant behavior in brittle rocks, 2:57474 (UCRL-79011)
GRAPHITE
See also PYROLYTIC CARBON
GRAPHITE/COMPATIBILITY
Compatibility of bismuth and bismuth-lithium solutions with refractory metals and graphite, 2:57108 (CONF-760503-P2)
GRAPHITE/HOT PRESSING
Chemical vapor deposition of tantalum on graphite cloth for making hot pressed fiber reinforced carbide-graphite composite, 2:57164 (LA-UR-77-1261)
GRAPHITE/MECHANICAL PROPERTIES
Feasibility of monitoring the strength of HTGR core support graphite: Part I, 2:56427 (BNWL-2239)
GRAPHITE/PHYSICAL RADIATION EFFECTS
Irradiation effects in boronated graphite, 2:56727
GRASS/METABOLISM
Simultaneous influx and efflux of nitrate during uptake by perennial ryegrass, 2:57418
GRASS/RADIONUCLIDE MIGRATION
Effects of substrate type and arsenic dosage level on arsenic behavior in grassland microcosms. Part I. Preliminary results on ^{74}As transport, 2:57380 (CONF-770647-1)
GREAT BRITAIN
See UNITED KINGDOM
GREENHOUSES/SOLAR SPACE HEATING
Solar energy applications in agriculture: potential, research needs, and adoption strategies, 2:56092 (PB-265105)
GRENOBLE REACTOR/REACTOR OPERATION
German-British-French high flux reactor in Grenoble and its research program, 2:56762
GROUND WATER/GEOCHEMICAL SURVEYS
Chemical and isotopic investigations of groundwater in potential geothermal areas in Hawaii, 2:56189
Mercury in underground waters of the West Siberian oil and gas bearing basin, 2:57477
GROUND WATER/SEISMIC EFFECTS
Seismicity and faulting attributable to fluid extraction, 2:55794
GROUND WATER/WATER QUALITY
The report to Congress: waste disposal practices and their effects on ground water. executive summary. Final report, 2:56957 (PB-265364)
GROUND WATER WITHDRAWAL
See FLUID WITHDRAWAL
GROUND-WATER RESERVES
See AQUIFERS
GUNDREMMINGEN-2 REACTOR/CONTAINMENT BUILDINGS
Liner design and construction for the thorium-cooled high-temperature reactor and the safety containment at the Gundremmingen-2 nuclear power plant, 2:56375
GUNDREMMINGEN-2 REACTOR/POWER TRANSMISSION LINES
Outage at Gundremmingen nuclear power plant caused by cold weather, 2:56378
GUNDREMMINGER KRB REACTOR
See RWE-BAYERNWERK REACTOR

H

HADRONS
See also BARYONS
RESONANCE PARTICLES
HADRONS/PARTICLE STRUCTURE
Double scattering in deuterium as a probe of hadron structure, 2:57583
HADRONS/WEAK INTERACTIONS
Weak interaction of colored hadrons, 2:57576
HAFNIUM 178 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
HALL GENERATORS
See MHD GENERATORS
HALOGENS/HOT ATOM CHEMISTRY
Gas to liquid to solid transition in halogen hot atom chemistry. IV. The suggestion of multiple enhancement reactions in high energy iodine-128-ethane systems, 2:57240
HAMAOKA-1 REACTOR/CONTAINMENT BUILDINGS
Experimental and analytical studies for a BWR nuclear reactor building: evaluation of soil-structure interaction behavior, 2:56398
HAMAOKA-1 REACTOR/FOUNDATIONS
Experimental and analytical studies for a BWR nuclear reactor building: evaluation of soil-structure interaction behavior, 2:56398
HAMAOKA-1 REACTOR/SEISMIC EFFECTS
Experimental and analytical studies for a BWR nuclear reactor building: evaluation of soil-structure interaction behavior, 2:56398
HANFORD ATOMIC PRODUCTS OPERATION
See HAPO
HANFORD RESERVATION/GROUND WATER
Hanford groundwater scenario studies, 2:57397 (ARH-SA-292)
HANFORD RESERVATION/LAND RECLAMATION
Land rehabilitation research at Pacific Northwest Laboratories, 2:57387 (BNWL-SA-6089)
HANFORD RESERVATION/PERSONNEL
Hanford reservation area worker census: a research report for the Rockwell Hanford Operations, 2:56916 (BNWL-2298)
HANFORD-2 REACTOR
See WNP-2 REACTOR
HAPO
(Hanford Atomic Products Operation.)
HAPO/RADIATION MONITORING
Plutonium in human lung in the Hanford environs, 2:57436 (BNWL-SA-5855)
HARTREE-FOCK METHOD
Hartree-Fock method with an effective interaction that depends on the density and on the self-consistency condition, 2:57616
HAWAII/GEOTHERMAL EXPLORATION
Chemical and isotopic investigations of groundwater in potential geothermal areas in Hawaii, 2:56189
HAWAII/GROUND WATER
Chemical and isotopic investigations of groundwater in potential geothermal areas in Hawaii, 2:56189
HAZARDOUS MATERIALS/STORAGE
Risks from the storage of hazardous chemicals, 2:57458 (PB-265115)
H-COAL PROCESS/RESIDUES
Gasification of residual materials from coal liquefaction. Quarterly report, October-December 1976, 2:55611 (FE-2247-1)
HEALTH PHYSICS
See RADIATION PROTECTION
HEART/SCINTISCANNING
Studies of the heart with ECG-gated scintigraphy, 2:57421
HEAT DISTRIBUTION SYSTEMS
Principles of design of schemes of district heating systems in cities, their automation, and installation of remote control facilities, 2:56913

HEAT EXCHANGERS
See also HEAT PUMPS
RADIATORS
HEAT EXCHANGERS/BIOLOGICAL FOULING
Heat transfer problems in an ocean thermal power plant, 2:56090 (COO-4041-2)
HEAT EXCHANGERS/COMPARATIVE EVALUATIONS
Investigation of the high-temperature recuperator of closed-cycle power plants operating on an inert gas, 2:56992
HEAT EXCHANGERS/CORROSION
Investigation of high-temperature reactor heat exchanger materials, 2:56431
HEAT EXCHANGERS/DESIGN
Application of boiling liquid metals in industrial processes, 2:56607 (CONF-760503-P1)
Boiler of tubular nature (Patent), 2:56200
Determination of optimal characteristics of plate-rib heat exchangers, 2:56257
Metallurgical problems of the he-to-he heat exchanger for advanced htr's, 2:56455
HEAT EXCHANGERS/EXPLOSION WELDING
Explosive plugging of nuclear heat exchangers, 2:56679
HEAT EXCHANGERS/FOULING
Silica vaporization and condensation: a potential source of fouling in coal combustion (4 refs), 2:55650 (UCRL-79146)
HEAT EXCHANGERS/PERFORMANCE TESTING
Investigation of the high-temperature recuperator of closed-cycle power plants operating on an inert gas, 2:56992
HEAT EXCHANGERS/WELDED JOINTS
Properties of explosive-welded Monel-clad steels, 2:56680
HEAT EXCHANGERS/WORKING FLUIDS
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
HEAT FLOW/DATA COMPILATION
World heat flow data collection, 1975, 2:56207
HEAT FLOW/MATHEMATICAL MODELS
Development of geothermal models, 2:56178
HEAT FLOW/REMOTE SENSING
Method for identifying anomalous terrestrial heat flows (Patent), 2:56181
HEAT LOSSES/MEASURING METHODS
Detecting structural heat losses with mobile infrared thermography. Part III. Survey of USA CRREL, 2:57003 (NP-22267)
HEAT OF SOLUTION
See SOLUTION HEAT
HEAT PIPES/FABRICATION
Heat pipes applied to flat-plate solar collectors. Final report, 2:56119 (COO/2604-76/1)
HEAT PIPES/HEAT TRANSFER
Investigation of heat exchange when liquids are boiled in closed two-phase thermosiphons, 2:57264
HEAT PIPES/PERFORMANCE TESTING
Heat pipes applied to flat-plate solar collectors. Final report, 2:56119 (COO/2604-76/1)
HEAT PUMPS/DESIGN
HYCSOS: a chemical heat pump and energy system based on metal hydrides, 2:57002 (ANL-77-39)
HEAT PUMPS/REVIEWS
Heat pumps: worldwide, 2:57005
HEAT PUMPS/THERMAL ENERGY STORAGE EQUIPMENT
HYCSOS: a chemical heat pump and energy system based on metal hydrides, 2:57002 (ANL-77-39)
HEAT PUMPS/USES
Heat pumps: worldwide, 2:57005
HEAT RECOVERY/WASTE HEAT
Comparison between regenerative and recuperative heat recovery systems in ventilating plants, 2:57045
HEAT RECOVERY EQUIPMENT/ECONOMICS
European waste-to-energy systems. An overview, 2:57022 (CONS/2103-6)
HEAT RECOVERY EQUIPMENT/OPERATION
European waste-to-energy systems. An overview, 2:57022 (CONS/2103-6)
HEAT RESISTING ALLOYS/CARBURIZATION
Materials for advanced high temperature reactors, 2:57139
HEAT RESISTING ALLOYS/CORROSION
High temperature corrosion in the thermochemical hydrogen production from nuclear heat, 2:55975
HEAT RESISTING ALLOYS/CREEP
Materials for advanced high temperature reactors, 2:57139
HEAT RESISTING ALLOYS/OXIDATION
Materials for advanced high temperature reactors, 2:57139
HEAT STORAGE
See also LATENT HEAT STORAGE
SENSIBLE HEAT STORAGE
THERMOCHEMICAL HEAT STORAGE
New directions in heat storage for buildings, 2:56153
HEAT STORAGE/MEETINGS
Sharing the Sun: solar technology in the seventies. Volume 8. Storage, water heater, data communication education. Contains sections 13.1, 13.2, 13.3, 15, 16, 5, 2:56016
HEAT TRANSFER
See also HEAT FLOW
HEAT TRANSFER/COMPUTER CODES
Data input manual for RSI/TRANCO: a finite element heat conduction computer program, 2:57475 (Y/OWI/SUB-77/22303/1)
HEAT TRANSMISSION
See HEAT TRANSFER
HEAVY ION REACTIONS
See also CARBON 12 REACTIONS
LITHIUM 6 REACTIONS
HEAVY ION REACTIONS/COMPOUND-NUCLEUS REACTIONS
Analysis of excitation functions in (HI,xn) reactions on the basis of a simple evaporation model (Analysis of 350 excitation functions), 2:57617
HEAVY IONS
Important problems in future heavy ion atomic physics, 2:57557
HEAVY OILS/WASTE PRODUCT UTILIZATION
Use of petroleum residues as binder in briquetting of coal, 2:55776
HEAVY WATER/DIELECTRIC PROPERTIES
Isotopic effects on the electronic properties of H_2O and D_2O in the vacuum uv, 2:57221
HEAVY WATER/OPTICAL PROPERTIES
Isotopic effects on the electronic properties of H_2O and D_2O in the vacuum uv, 2:57221
HEAVY WATER COOLANT
See HEAVY WATER
HEAVY WATER MODERATED REACTORS
See also ALRR REACTOR
CANDU TYPE REACTORS
FR-2 REACTOR
GRENOBLE REACTOR
PHWR TYPE REACTORS
SGHWR REACTOR
HEAVY WATER MODERATED REACTORS/FUEL ELEMENTS
Fuel element for heavy water moderated nuclear reactors (Patent), 2:56467
HELIUM/AUTOIONIZATION
Decay of autoionization states in collisions of heavy atomic particles, 2:57509
HELIUM/DIELECTRIC PROPERTIES
Electrical breakdown and tracking characteristics of pulsed high voltages in cryogenic helium and nitrogen, 2:57742
HELIUM/ELECTRON-ATOM COLLISIONS
Electron impact excitation of light atoms (Review, cross sections), 2:57522
HELIUM/ENERGY LEVELS
Decay of autoionization states in collisions of heavy atomic particles, 2:57509
HELIUM/MOLECULE-MOLECULE COLLISIONS
Study of momentum transfer distributions in rotationally inelastic collisions (Peripheral collisions, anisotropy), 2:57551
HELIUM/NUCLEAR REACTION YIELD
Hydrogen and helium production cross sections for 15-MeV neutrons on types 316 and 304 stainless steel, 2:57594
HELIUM/PHASE TRANSFORMATIONS
Fluctuational character of phase transition development in liquid helium (0.8 to 4°K), 2:57561
HELIUM/REMOVAL
Cryopumping of deuterium hydrogen and helium mixtures on smooth 4.2 K surfaces, 2:57785 (BNL-22759)
HELIUM/RESEARCH PROGRAMS
Helium research in support of superconducting power transmission. Annual report, July 1975-September 1976, 2:56360 (CONS/3800-1)
HELIUM/THERMODYNAMIC PROPERTIES
Helium research in support of superconducting power transmission. Annual report, July 1975-September 1976, 2:56360 (CONS/3800-1)
HELIUM 4
HELIUM I
See also HELIUM II
HELIUM 4/DIFFUSION
Mathematical models for transport of tritium and helium-4 in solid breeders, 2:57765
HELIUM I/DENSITY
Fluctuational character of phase transition development in liquid helium, 2:57561
HELIUM I/PHASE TRANSFORMATIONS
Fluctuational character of phase transition development in liquid helium, 2:57561

HELIUM II/DENSITY
Fluctuational character of phase transition development in liquid helium, 2:57561
HELIUM II/PHASE TRANSFORMATIONS
Fluctuational character of phase transition development in liquid helium, 2:57561
HELIUM IONS/ELECTRON-ION COLLISIONS
(e,2e) reaction, 2:57550
HELIUM IONS/ENERGY LEVELS
(e,2e) reaction, 2:57550
HELIUM-NEON LASERS/FREQUENCY CONTROL
Experimental investigation of He:Ne lasers stabilized by saturation absorption in iodine, 2:57289
HEREDITY
See GENETICS
HETEROCYCLIC COMPOUNDS
See also PHTHALOCYANINES
PYRIDINES
HETEROCYCLIC COMPOUNDS/CHEMICAL PREPARATION
Physical and chemical behavior of liquefied coal in solids separation. Quarterly report, January-March 1977 (9 refs), 2:55613 (FE-2550-2)
HEXAPOLAR CONFIGURATIONS/CHARGED-PARTICLE TRANSPORT
Polarized particle levitation in hexapole field, 2:57770 (UCRL-13735-2)
HIGH BTU GAS/COST
Synthesis of substitute natural gas based on coal (21 refs), 2:55586
HIGH BTU GAS/PRODUCTION
Economic comparison of two BIGAS coal gasification processes (Bigas at 1200 psig and modified Bigas at 470 psig), 2:55570 (FE-2024-4)
Gasification of hydrocarbon feedstocks (Patent; 18 claims), 2:55985
High- and low-Btu gas from Montana subbituminous coal, 2:55564 (CONF-770814-3)
Status report at the end of the concept phase, 1 August 1975-30 November 1976 (Nuclear coal gasification), 2:55590 (ERDA-tr-296)
HIGH BTU GAS/RESEARCH PROGRAMS
Success at Westfield, 2:55587
HIGH BTU GAS/SYNTHESIS
ERDA demonstration plant program for high-Btu gas, 2:55594
Process and apparatus for the production of combustible gas (Patent; by carbonization and gasification of waste materials and other combustible materials), 2:55992
Process for producing combustible gases (Patent; by decomposing methanol and methanating resulting gas), 2:55984
HIGH ENERGY PHYSICS
Ukrainian Physics Journal (Cover-to-cover translation into English of Ukrainskii Fizicheskii Zhurnal, no. 9 (September 1971)), 2:57089 (AEC-tr-7297/9)
HIGH EXPLOSIVES
See CHEMICAL EXPLOSIVES
HIGH-BETA PLASMA/CONFINEMENT TIME
Evolution and thermonuclear yield of a high β plasma column, 2:57631
HIGH-BETA PLASMA/FUSION YIELD
Evolution and thermonuclear yield of a high β plasma column, 2:57631
HIGH-TEMPERATURE GAS-COOLED REACTOR
See HTGR TYPE REACTORS
HIGHWAYS
See ROADS
HOMOGENEOUS PLASMA/DECAY INSTABILITY
Three-wave parametric-decay instability with arbitrary dissipation in homogeneous plasmas, 2:57669
HOMOGENEOUS PLASMA/PARAMETRIC INSTABILITIES
Unified formalism of lower hybrid parametric instabilities in plasmas, 2:57668
HOPE CREEK-1 REACTOR/REACTOR SAFETY
Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I-VI, 2:56787 (ORNL/NUREG/NSIC-136)
HOPE CREEK-2 REACTOR/REACTOR SAFETY
Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I-VI, 2:56787 (ORNL/NUREG/NSIC-136)
HOPPERS/PERFORMANCE TESTING
Coal pressurization and feeding use of a lock hopper system, 2:55563 (CONF-770655-1)
HOT PLASMA
See also LASER-PRODUCED PLASMA
HOT PLASMA/IMPURITIES
Local diagnostics of impurity ions in a hot plasma, 2:57637
HOT PLASMA/PLASMA DIAGNOSTICS
Local diagnostics of impurity ions in a hot plasma, 2:57637
HOT SPRINGS/GEOCHEMICAL SURVEYS
Antimony content in the hot spring waters in Gunma Prefecture, 2:56190
Boric acid content of hot springs and river waters at Owakudani Valley, Volcano Hakone, 2:56192
Calcium chloride springs of sea water origin in Toi Hot Spring, 2:56191
Determination of trace elements in hot spring water by anode stripping voltametry, 2:56211
Heat discharge measurement and geophysical prospecting at Nigorikawa basin, northern part of Komagatake, 2:56183
HOT SPRINGS/GEOCHEMISTRY
Factors influencing crystalline form of calcareous sinters, 2:56213
HOT SPRINGS/GEOPHYSICAL SURVEYS
Heat discharge measurement and geophysical prospecting at Nigorikawa basin, northern part of Komagatake, 2:56183
HOT SPRINGS/HEAT TRANSFER
Heat discharge measurement and geophysical prospecting at Nigorikawa basin, northern part of Komagatake, 2:56183
Total heat discharge from northern Azuma geothermal area, 2:56184
HOT SPRINGS/TEMPERATURE MEASUREMENT
Ground temperature surveys and thermal discharge measurements at Ibusuki and its surrounding geothermal areas, 2:56185
Observation of temperature and water level in Hakone volcano, 1973, 2:56179
HOT SPRINGS/VOLTAMETRY
Determination of trace elements in hot spring water by anode stripping voltametry, 2:56211
HOT-DRY-ROCK SYSTEMS/HEAT EXTRACTION
Heat extraction from hot, dry rock masses. Progress report 1 Feb-31 Jul 76, 2:56204 (PB-265116)
HOT-DRY-ROCK SYSTEMS/HYDRAULIC FRACTURING
Heat extraction from hot, dry rock masses. Progress report 1 Feb-31 Jul 76, 2:56204 (PB-265116)
HOT-DRY-ROCK SYSTEMS/MATHEMATICAL MODELS
Utilization of geothermal energy in dry rock masses, 2:56171
HOT-DRY-ROCK SYSTEMS/POWER POTENTIAL
Utilization of geothermal energy in dry rock masses, 2:56171
HOUSES/AIR POLLUTION CONTROL
Control of the level of NO/sub x/ in the indoor environment, 2:57459 (CONF-770557-2)
HOUSES/ARCHITECTURE
Solar energy system design approaches for architects, 2:56108
HOUSES/ENERGY CONSERVATION
Energy and cost analysis of residential water heaters, 2:57014 (ORNL/CON-10)
HOUSES/SOLAR SPACE HEATING
Design of a solar heating system using seasonal heat storage (Provident House), 2:56107
Solar glass house with subsoil heat accumulator, 2:56104
HOUSES/SOLAR WATER HEATERS
Design of a solar heating system using seasonal heat storage (Provident House), 2:56107
HOUSES/SPACE HEATING
Household fuel demand analysis, 2:57013 (CONF-770225-1)
HOUSES/WATER HEATERS
Energy and cost analysis of residential water heaters, 2:57014 (ORNL/CON-10)
HTGR PEACH BOTTOM REACTOR
See PEACH BOTTOM-1 REACTOR
HTGR TYPE REACTORS
See also PEACH BOTTOM-1 REACTOR
THTR-300 REACTOR
Germany plans process heat schemes for HTGR, 2:56609
HTGR TYPE REACTORS/CLOSED-CYCLE COOLING SYSTEMS
Aluminum as construction material for cooling towers, 2:56456
HTGR TYPE REACTORS/COATED FUEL PARTICLES
Interaction of LaC_2 and NdC_2 with SiC in HTGR particles, 2:56428 (CONF-770708-5)
Kernel migration for HTGR fuels from the system Th-U-Pu-C-O-N, 2:56446
Mixing of particles in a spouted bed (Patent; HTGR), 2:56451
Preparation of fuel elements for high temperature gas cooled reactors (Patent), 2:56457
Transient behavior of HTGR fuel particles, 2:56433
HTGR TYPE REACTORS/COOLING TOWERS
Aluminum as construction material for cooling towers, 2:56456
HTGR TYPE REACTORS/DEPRESSURIZATION
Consequences of ultimate sequences of HTGRs, 2:56804
Layering and combustion in the HTGR containment following depressurization accident, 2:56803
HTGR TYPE REACTORS/DIRECT CYCLE COOLING SYSTEMS
Europe pushes direct cycle development, 2:56438
HTGR TYPE REACTORS/ECCS
Method for urgently cooling a core in high temperature gas reactor (Patent), 2:56458

HTGR TYPE REACTORS/FUEL CYCLE
HTGR offers chance to stretch fuel reserves, 2:56437
HTR near-breeder concept as a means of saving fissile material, 2:56442
Nuclear fuel cycle: (4) the reactors, 2:56606
HTGR TYPE REACTORS/FUEL ELEMENTS
Spherical fuel element for high temperature reactors, 2:56452
HTGR TYPE REACTORS/FUEL MANAGEMENT
Resource utilization of symbiotic HTGR systems, 2:56434
HTGR TYPE REACTORS/GAS TURBINES
Cooling of nuclear power plants equipped with high-temperature reactors and helium turbine cycles, 2:56443
Gas turbine HTGR program. Quarterly progress report for the period ending March 31, 1977, 2:56429 (GA-A-14381)
Nuclear gas turbine power plant activities in the United States, 2:56447
HTGR TYPE REACTORS/HEAT EXCHANGERS
Investigation of high-temperature reactor heat exchanger materials, 2:56431
Metallurgical problems of the he-to-he heat exchanger for advanced htr's, 2:56455
HTGR TYPE REACTORS/HYDROGEN PRODUCTION
Method for the production of hydrogen by water splitting (Patent), 2:56614
Plant for producing hydrogen by utilizing the thermal energy generated in a gas-cooled high-temperature reactor (Patent), 2:56612
Preliminary systems-engineering study of an advanced nuclear-electrolytic hydrogen-production facility, 2:56430 (NP-22192)
HTGR TYPE REACTORS/LOSS OF FLOW
HTGR fuel failure in the absence of core cooling, 2:56802
HTGR TYPE REACTORS/NEUTRON ABSORBERS
Irradiation effects in boronated graphite, 2:56727
HTGR TYPE REACTORS/PRESSURE VESSELS
Cylindrical prestressed concrete tank for a nuclear power plant (Patent; HTGR), 2:56432
Gas-cooled nuclear reactor with a pressure vessel with liners (Patent), 2:56444
HTGR TYPE REACTORS/REACTOR ACCIDENTS
Evaluation of integral experiments and potential test facilities for future HTGR fission product safety research, 2:56775 (GA-A-14205)
HTGR TYPE REACTORS/REACTOR COOLING SYSTEMS
Cooling of nuclear power plants equipped with high-temperature reactors and helium turbine cycles, 2:56443
HTGR TYPE REACTORS/REACTOR CORES
Behaviour of tritium in a graphite reactor, 2:56441
Feasibility of monitoring the strength of HTGR core support graphite: Part I, 2:56427 (BNWL-2239)
HTGR TYPE REACTORS/REACTOR MATERIALS
High temperature materials requirements in reforming of gaseous hydrocarbons with HTR heat, 2:56613
Materials for advanced high temperature reactors, 2:57139
HTGR TYPE REACTORS/REACTOR OPERATION
Operating U.S. power reactors, 2:56382
HTGR TYPE REACTORS/ROD EJECTION ACCIDENTS
Comparison of one- and two-dimensional models of a control rod ejection accident in the HTGR, 2:56805
HTGR TYPE REACTORS/SEISMIC EFFECTS
MODSAP: a modified version of the program SAP IV for the static and dynamic response of linear and localized nonlinear structures, 2:57808 (GA-A-14405)
HTGR TYPE REACTORS/TURBOMACHINERY
Ammonia turbomachinery design considerations for the direct cycle nuclear gas turbine waste heat power plant, 2:56440
Design of turbomachinery for the gas turbine (direct cycle) high temperature gas cooled reactor power plant, 2:56439
HUMAN CELLS
See ANIMAL CELLS
HUMAN POPULATIONS/MORTALITY
Health hazards of alternative electricity generation fuel cycles, 2:57404
HUMAN POPULATIONS/RADIATION DOSES
Estimation and control of population dose within buildings, 2:57432
HUMAN POPULATIONS/RADIATION MONITORING
Dose assessment at Bikini Atoll (^{90}Sr, ^{137}Cs), 2:57437 (UCRL-51879(Pt.5))
HUMIDITY/CORROSIVE EFFECTS
The stress corrosion resistance and the cryogenic temperature mechanical properties of annealed Nitronic 60 bar material, 2:57115 (N-77-16149)
HUTCHINSON ISLAND-1 REACTOR
See LUCIE-1 REACTOR
HWGCR OF CZECHOSLOVAKIA
BOHUNICE A-1 REACTOR
HYBRID REACTORS/ACCIDENTS
Accidental criticality of fusion/fission hybrid blanket designs, 2:57745
HYBRID REACTORS/BREEDING BLANKETS
Parameter matching for the breeding blanket, 2:57728
HYBRID REACTORS/BREEDING RATIO
Comparative breeding characteristics of fusion and fast reactors, 2:57748
HYBRID REACTORS/COMPARATIVE EVALUATIONS
Comparative breeding characteristics of fusion and fast reactors, 2:57748
HYBRID REACTORS/COST
Laser fusion hybrid reactor systems study, 2:57769 (UCRL-13720)
HYBRID REACTORS/DESIGN
Conceptual approach to laser fusion hybrid reactor, 2:57778
Laser fusion hybrid reactor systems study, 2:57769 (UCRL-13720)
Reference mirror hybrid fusion-fission reactor design, 2:57713
HYBRID REACTORS/FEASIBILITY STUDIES
Energetics assessment of the potential of the fusion-fission hybrid reactor system, 2:57709
Optimization process in the PPL hybrid study, 2:57710
HYBRID REACTORS/LOSS OF COOLANT
Blanket cooling under accident conditions in fusion-fusion hybrid power reactors, 2:57743
HYBRID REACTORS/OPTIMIZATION
Optimization process in the PPL hybrid study, 2:57710
HYBRID REACTORS/POWER GENERATION
Energy supply system modeling, 2:57701
HYBRID REACTORS/REVIEWS
Review of the mirror hybrid reactor, 2:57690 (UCRL-79548)
HYDRATED ELECTRONS
See SOLVATED ELECTRONS
HYDRAULIC EQUIPMENT/TESTING
Rubber pipe for hydraulic stowing, 2:55718
HYDRAULIC TURBINES
See also TURBOGENERATORS
HYDRAULIC TURBINES/DESIGN
Hydrodynamic theory of supercavitating pumps or hydroturbines, 2:56007
Specific features of construction and assembly of rotor chambers of large rotary blade hydraulic turbines, 2:56009
HYDRAULIC TURBINES/FABRICATION
Specific features of construction and assembly of rotor chambers of large rotary blade hydraulic turbines, 2:56009
HYDRAULIC TURBINES/FUNCTIONAL MODELS
Modeling of loads on hydraulic machinery blades, 2:56010
HYDRAULIC TURBINES/PERFORMANCE TESTING
Comparative analysis of measuring instruments with evaluation of errors of determination of principal parameters in model tests of hydraulic turbines, 2:57344
HYDRAULIC TURBINES/TURBINE BLADES
Effect of small geometric deviations of the shape of rotor blades of hydraulic turbines on their hydraulic qualities and cavitation erosion, 2:56005
Modeling of loads on hydraulic machinery blades, 2:56010
Profiling of blades of the working region of the hydraulic turbines in vortex-type flow, 2:56008
HYDRAZINE/OXIDATION
Kinetics of the reaction between hydrazine and nitric acid catalyzed by molybdenum(VI), 2:55996
HYDRIODIC ACID/CORROSIVE EFFECTS
High temperature corrosion in the thermochemical hydrogen production from nuclear heat, 2:55975
HYDROBROMIC ACID/CORROSIVE EFFECTS
High temperature corrosion in the thermochemical hydrogen production from nuclear heat, 2:55975
HYDROCARBONS
See also ALKANES
ALKENES
ALKYNES
BENZENE
BENZOPYRENE
TOLUENE
HYDROCARBONS/CHEMICAL PROPERTIES
Classification of hydrocarbon pools, 2:55802
HYDROCARBONS/CHROMATOGRAPHY
Geochemical provinces revealed in Toarcian oil shales in the eastern Paris Basin. Analysis of the soluble organic fraction, 2:55830
HYDROCARBONS/COMBUSTION PRODUCTS
Influence of additives obtained from alkaline metals on soot concentration of hydrocarbon diffusive-laminar flames, 2:55980
Production of nitrogen compounds from molecular nitrogen in fuel-rich hydrocarbon-air flames, 2:57244
HYDROCARBONS/GASIFICATION
Gasification of hydrocarbon feedstocks (Patent; 18 claims), 2:55985
HYDROCARBONS/PHYSICAL PROPERTIES
Classification of hydrocarbon pools, 2:55802

HYDROCARBONS/SOLVENT EXTRACTION
Geochemical provinces revealed in Toarcian oil shales in the eastern Paris Basin. Analysis of the soluble organic fraction, 2:55830
HYDROCHLORIC ACID/CORROSIVE EFFECTS
High temperature corrosion in the thermochemical hydrogen production from nuclear heat, 2:55975
HYDROCYANIC ACID/CHEMICAL REACTION YIELD
Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, 11 September-10 December 1976 (5 refs), 2:55723 (FE-2018-6)
Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, December 11, 1976-March 10, 1977, 2:55724 (FE-2018-7)
Production of nitrogen compounds from molecular nitrogen in fuel-rich hydrocarbon-air flames, 2:57244
HYDROELECTRIC POWER/AVAILABILITY
Waterpower: a short overview, 2:56003
HYDROELECTRIC POWER/ENVIRONMENTAL IMPACTS
Waterpower: a short overview, 2:56003
HYDROELECTRIC POWER/WATER RESOURCES
Impacts of the western drought on regional electricity generation. Interim report, 2:56975 (PB-265 641)
HYDROELECTRIC POWER PLANTS
See also PUMPED STORAGE POWER PLANTS
HYDROELECTRIC POWER PLANTS/CONSTRUCTION
Major rock excavations at Dinorwic, Wales, 2:56004
HYDROELECTRIC POWER PLANTS/ELECTRIC GENERATORS
Problems of technology of manufacture of hydraulic generator shafts and related consequences for assembly and operation of hydraulic units, 2:56011
HYDROELECTRIC POWER PLANTS/ENVIRONMENTAL EFFECTS
Should dams be built. The Volta Lake example, 2:56013
HYDROELECTRIC POWER PLANTS/ENVIRONMENTAL IMPACT STATEMENTS
Significant interrelationships between electric power generation and natural and developed resources in the Connecticut River Basin, 2:56012 (PB-264753)
HYDROELECTRIC POWER PLANTS/HYDRAULICS
Hydraulic calculation of hydroelectric power station spillways, 2:56006
HYDROELECTRIC POWER PLANTS/LICENSING
Water resources appraisal for hydroelectric licensing Kern River Basin, California, 2:56002 (PB-264750)
HYDROELECTRICITY
See HYDROELECTRIC POWER
HYDROGEN/COMBUSTION KINETICS
Computational simulation of shock-induced gas-phase reactions, 2:57247
HYDROGEN/COMBUSTION PROPERTIES
Investigation of a turbulent free-jet flame with chemical unbalance, 2:55976
HYDROGEN/COMPRESSION
Shock compression of liquid hydrogen in various experimental geometries, 2:55979
HYDROGEN/ELECTRON COLLISIONS
Angular correlation of electrons coming from ionization by electron impact (Reviews), 2:57527
HYDROGEN/ELECTRON-ATOM COLLISIONS
Electron impact excitation of light atoms (Review, cross sections), 2:57522
Inelastic electron-hydrogen atom experiments (Review), 2:57523
HYDROGEN/ELECTRON-MOLECULE COLLISIONS
Laser photodissociation of hydrogen molecule ions with fragment kinetic energy analysis, 2:57506
Theory of low energy electron-molecule scattering (Reviews), 2:57528
HYDROGEN/FLAMES
Investigation of a turbulent free-jet flame with chemical unbalance, 2:55976
HYDROGEN/IGNITION
Explosion limits of hydrogen-oxygen mixture as a stochastic phenomenon, 2:55977
HYDROGEN/MOLECULE-MOLECULE COLLISIONS
Study of momentum transfer distributions in rotationally inelastic collisions (Peripheral collisions, anisotropy), 2:57551
HYDROGEN/NUCLEAR REACTION YIELD
Hydrogen and helium production cross sections for 15-MeV neutrons on types 316 and 304 stainless steel, 2:57594
HYDROGEN/OXIDATION
Mechanism of the oxidation of hydrogen on platinum, 2:55978
HYDROGEN/PHOTON-MOLECULE COLLISIONS
Laser photodissociation of hydrogen molecule ions with fragment kinetic energy analysis, 2:57506
HYDROGEN/REMOVAL
Cryopumping of deuterium hydrogen and helium mixtures on smooth 4.2 K surfaces, 2:57785 (BNL-22759)
HYDROGEN/VIBRATIONAL STATES
Laser photodissociation of hydrogen molecule ions with fragment kinetic energy analysis, 2:57506
HYDROGEN 2
See DEUTERIUM
HYDROGEN 3
See TRITIUM
HYDROGEN BROMIDES
See HYDROBROMIC ACID
HYDROGEN CHLORIDES
See HYDROCHLORIC ACID
HYDROGEN CYANIDES
See HYDROCYANIC ACID
HYDROGEN DEUTERIDE/ELECTRON-MOLECULE COLLISIONS
Laser photodissociation of hydrogen molecule ions with fragment kinetic energy analysis, 2:57506
HYDROGEN DEUTERIDE/VIBRATIONAL STATES
Laser photodissociation of hydrogen molecule ions with fragment kinetic energy analysis, 2:57506
HYDROGEN FUELS/BIBLIOGRAPHIES
Energy, 2:57834
HYDROGEN IONS
See also HYDROGEN IONS 1 PLUS
HYDROGEN IONS/COLLISIONS
Model of secondary electron yields from atomic and polyatomic ion impacts on copper and tungsten surfaces based upon stopping-power calculations, 2:57495
HYDROGEN IONS 1 PLUS/COLLISIONS
Sputtering of niobium by energetic neutrons and protons: A round-robin experiment (MeV range), 2:57494
HYDROGEN IONS 1 PLUS/ION-ATOM COLLISIONS
Study of K, L, and M inner-shell ionization by proton impact (Total cross sections, 150 to 500 Kev, Born approximation), 2:57539
HYDROGEN ISOTOPES/ISOTOPIC EXCHANGE
Electrochemical determination of equilibrium constants for isotope-exchange reactions, 2:57228
HYDROGEN ISOTOPES/PRESSURIZERS
High pressure apparatus for hydrogen isotopes to pressures of 345 MPa (50,000 psi) and temperatures of 1200°C, 2:57253 (UCRL-78886)
HYDROGEN METERS
Application of in situ analysis to hydrogen-related materials problems, 2:57337
HYDROGEN METERS/OPERATION
Profiling hydrogen and helium in materials using ion beams, 2:57338
HYDROGEN PEROXIDE/CHEMICAL REACTION YIELD
Mechanism of the disproportionation of superoxide radicals (23°C; pH range 6.1-13.8), 2:57235
HYDROGEN PEROXIDE/FORMATES
Energetics and mechanism of sonochemical reactions. V. The formation of hydrogen peroxide in the sonolysis of water and aqueous solutions of formates, 2:55998
HYDROGEN PEROXIDE/SYNTHESIS
Energetics and mechanism of sonochemical reactions. V. The formation of hydrogen peroxide in the sonolysis of water and aqueous solutions of formates, 2:55998
HYDROGEN PRODUCTION
Preliminary systems-engineering study of an advanced nuclear-electrolytic hydrogen-production facility, 2:56430 (NP-22192)
HYDROGEN PRODUCTION/REFORMER PROCESSES
Plant for producing hydrogen by utilizing the thermal energy generated in a gas-cooled high-temperature reactor (Patent), 2:56612
HYDROGEN PRODUCTION/SOLAR ENERGY CONVERSION
Assessment of hydrogen as a means to store solar energy, 2:56027
HYDROGEN PRODUCTION/THERMOCHEMICAL PROCESSES
High temperature corrosion in the thermochemical hydrogen production from nuclear heat, 2:55975
Method for the production of hydrogen by water splitting (Patent), 2:56614
HYDROGEN STORAGE
See also CRYOGENICS
TANKS
HYDROGEN STORAGE/REVIEWS
Assessment of hydrogen as a means to store solar energy, 2:56027
HYDROGEN SULFATES
See SULFURIC ACID
HYDROGEN SULFIDES/CORROSIVE EFFECTS
Geothermal power plants and their material trends, 2:56202
Sulfidation of 310 stainless steel at sulfur potentials encountered in coal conversion systems, 2:55548 (N-76-31332)
HYDROGEN SULFIDES/REMOVAL
Removal of contaminants from industrial gaseous effluents, 2:55654

HYDROGEN SULFIDES/TOXICITY
Safety conditions during testing of oil and gas bearing formations containing hydrogen sulfide, 2:55781
HYDROGENATION/CATALYSTS
Catalytic hydrogenation of coal-derived liquids. Interim report, March 1977-May 1977 (Co molybdate), 2:55556 (FE-2034-7)
HYDRONIUM IONS
See OXONIUM IONS
HYDROSPHERE/ORIGIN
Early evolution of the terrestrial atmosphere and hydrosphere, 2:57490
HYGAS PROCESS/COMPARATIVE EVALUATIONS
High- and low-Btu gas from Montana subbituminous coal, 2:55564 (CONF-770814-3)
HYGAS PROCESS/COST
High- and low-Btu gas from Montana subbituminous coal, 2:55564 (CONF-770814-3)
HYGAS PROCESS/PRESSURE VESSELS
Feasibility study of prestressed concrete pressure vessels for coal gasifiers, 2:55583 (ORNL-5312)
HYPERTENSION/GENETIC VARIABILITY
Genetic influence on hypertension induced by cadmium in Dahl hypertension-resistant and hypertension-sensitive rats, 2:57427

I

I-BEAM TYPE REACTORS
Reactor considerations of ion beam-pellet fusion, 2:57780
I-BEAM TYPE REACTORS/FIRST WALL
First-wall costs of an ion-beam fusion reactor, 2:57794
I-BEAM TYPE REACTORS/MODERATORS
Liquid-wall boiler and moderator (BAM) for heavy ion-pellet fusion reactors, 2:57793
I-BEAM TYPE REACTORS/PLANNING
Potential for ion-beam fusion, 2:57777
IMAGE CONVERTERS/SENSITIVITY
Infrared upconverter for astronomical imaging, 2:57341
IMMUNITY
Mechanisms of innate immunity: cytoplasmic granules of polymorphonuclear neutrophilic granulocytes, antimicrobial action, translocation, role, and fate in antimicrobial phagocytosis. Progress report, March 1976-June 30, 1977, 2:57413 (ORO-3628-11)
Studies in developmental immunogenetics. Annual progress report, 2:57406 (CALT-767P6-X12)
IMPERIAL VALLEY/GEOTHERMAL FIELDS
Predicting the effect of geothermal emissions on the temperature and relative humidity in the Imperial Valley of California, 2:56197
IMPERMEABLE DRY ROCK
See HOT-DRY-ROCK SYSTEMS
INCIDENTS
See ACCIDENTS
INCINERATORS/DESIGN
European waste-to-energy systems. An overview, 2:57022 (CONS/2103-6)
INCOLOY 800/CORROSION
Investigation of high-temperature reactor heat exchanger materials, 2:56431
INCOLOY 800/MECHANICAL PROPERTIES
Alloy 800 for liquid-metal fast breeder reactor steam generators, 2:56565
Qualification of Alloy 800 for sodium heated steam generators (LMFBR), 2:56505 (CONF-760503-P1)
INCONEL 600/FATIGUE
Cyclic stress strain behavior of four nuclear pressure vessel materials, 2:56676
INCONEL 671/EROSION
Testing, identification, and evaluation of commercial and "advanced experimental" materials and coatings under design conditions simulating fuel power cycle combinations. Task II. Evaluation of heat exchanger materials for use in coal-fired fluidized bed combustion environment. Monthly technical progress report No. 14, 2:55725 (FE-2325-14)
INCONEL 718/FRICTION
Investigations into the self-welding behavior of metallic materials exposed to sodium, 2:56499 (CONF-760503-P1)
IN-CORE FUEL MANAGEMENT
See FUEL MANAGEMENT
INDIA/COAL DEPOSITS
Prereduction of iron ore (17 refs), 2:55667
Semi-coking coal resources of Raniganj coalfield (12 refs), 2:55666
INDIA/COAL MINES
Extracting coal standing on pillars by modified longwall method, 2:55700
Investigation into strata behaviour around an experimental longwall caving face in Jharia coalfield (14 refs), 2:55699
INDIA/METAL INDUSTRY
Semi-coking coal resources of Raniganj coalfield (12 refs), 2:55666
INDIUM COMPLEXES/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance studies of diamagnetic metal-aminopolycarboxylate complexes, 2:57229
INDONESIA/ENERGY POLICY
Oil in Indonesia, 2:55795
INDUSTRIAL PLANTS
See also OIL SHALE PROCESSING PLANTS
PETROCHEMICAL PLANTS
WASTE PROCESSING PLANTS
INDUSTRIAL PLANTS/AIR POLLUTION CONTROL
Lowering of pollutant content in emissions from fuel combustion in boilers of middle capacity, 2:55791
INDUSTRIAL PLANTS/ENERGY CONSERVATION
Energy-conservation standards loom for buildings and industrial processes, 2:56942
Heat recuperator: improved heat transfer efficiency, 2:57044
Reducing power consumption in olefin plants, 2:57040
INDUSTRIAL PLANTS/ENERGY CONSUMPTION
Needs and opportunities for ceramic science and technology, 2:57032 (COO-2390-15)
INDUSTRIAL PLANTS/ENERGY MANAGEMENT
Energy conservation in dyeing and finishing, 2:56944
Practical meaning of energy management, 2:56943
INDUSTRIAL PLANTS/FIBERS
Fibers as renewable resources for industrial materials (Review and assessment), 2:56928 (PB-264561)
INDUSTRIAL PLANTS/LOW BTU GAS
Low-Btu gas from coal has many potential markets, 2:56966
INDUSTRIAL PLANTS/MATERIALS
Fibers as renewable resources for industrial materials (Review and assessment), 2:56928 (PB-264561)
INDUSTRIAL PLANTS/PROCESS HEAT
Characterization of industrial process heat, including the potential for solar or nuclear systems to supply this market, 2:56094
INDUSTRIAL PLANTS/WASTE HEAT
Waste heat management guidebook. Final report, 2:57043 (PB-264959)
INDUSTRIAL PLANTS/WASTE MANAGEMENT
Recycling waste (Book), 2:56925
INDUSTRIAL PLANTS/WASTES
Recycling waste (Book), 2:56925
INDUSTRIAL WASTES/ENVIRONMENTAL EFFECTS
State of the art: wastewater management in the beverage industry, 2:57047 (EPA-600/2-77-048)
INDUSTRIAL WASTES/MONITORING
Fishing for toxicity: biological automonitor for continuous water quality control, 2:57396
INDUSTRIAL WASTES/RECYCLING
State of the art: wastewater management in the beverage industry, 2:57047 (EPA-600/2-77-048)
Thermodynamic estimation of the minimum concentration attainable in a flow-through porous electrode reactor, 2:57048
INDUSTRY
See also CHEMICAL INDUSTRY
COAL INDUSTRY
DEVELOPING COUNTRIES
METAL INDUSTRY
MINERAL INDUSTRY
NATURAL GAS INDUSTRY
OIL SHALE INDUSTRY
PAPER INDUSTRY
PETROLEUM INDUSTRY
SYNTHETIC FUELS INDUSTRY
TEXTILE INDUSTRY
INDUSTRY/ENERGY CONSUMPTION
Industrial applications of solar energy. Quarterly report, 2:56093 (SAN/1132-1)
INDUSTRY/SOLAR ENERGY
Industrial applications of solar energy. Quarterly report, 2:56093 (SAN/1132-1)
INFORMATION CENTERS
Biohazards of energy production, distribution, use, and conservation: information sources, 2:57460 (CONF-7605159-1)
Power engineering branch system of scientific and technical information in the tenth five year plan period, 2:56230
INFORMATION RETRIEVAL/MATHEMATICAL MODELS
Comparison of the extended set theory and relational approaches to data base management, 2:57833 (UCRL-79357)
INFORMATION SYSTEMS
Power engineering branch system of scientific and technical information in the tenth five year plan period, 2:56230
INFORMATION SYSTEMS/ON-LINE SYSTEMS
Time for atomic and molecular data bases is now (an overview of data management research at LLL), 2:57832 (UCRL-79286)

INFRARED RADIATION/IMAGE CONVERTERS
Infrared upconverter for astronomical imaging, 2:57341
INFRARED THERMOGRAPHY
Detecting structural heat losses with mobile infrared thermography. Part III. Survey of USA CRREL, 2:57003 (NP-22267)
INHOMOGENEOUS PLASMA/BERNSTEIN MODE
Radiation coupling of Bernstein modes in a ring plasma, 2:57680
INHOMOGENEOUS PLASMA/CONVECTIVE INSTABILITIES
Influence of strong inhomogeneities on high-frequency mirror-drift-cone and convective-loss-cone instabilities, 2:57667
INHOMOGENEOUS PLASMA/DRIFT INSTABILITY
Influence of strong inhomogeneities on high-frequency mirror-drift-cone and convective-loss-cone instabilities, 2:57667
Initial value problem with non-Hermitian radial mode equations, 2:57665
INHOMOGENEOUS PLASMA/LASER RADIATION
Wave-breaking amplitudes in warm, inhomogeneous plasmas, 2:57676 (UCRL-79604)
INHOMOGENEOUS PLASMA/LOSS CONE INSTABILITY
Influence of strong inhomogeneities on high-frequency mirror-drift-cone and convective-loss-cone instabilities, 2:57667
INHOMOGENEOUS PLASMA/PLASMA WAVES
Nonlinear distortion of propagation cones of lower hybrid wave in an inhomogeneous plasma, 2:57679
INORGANIC COMPOUNDS/CHEMICAL REACTION KINETICS
Reaction mechanisms of organic and inorganic ions in the gas phase, 2:57220
IN-SITU GASIFICATION
Investigation of aromatic fractions from coal tar produced by an underground coal gasification test, 2:55561 (CONF-770510-7)
Method of processing coal channels in underground coal gasification (Patent; 2 claims), 2:55585
IN-SITU GASIFICATION/ECONOMIC IMPACT
Underground gasification offers clean safe route to coal energy, 2:56962
IN-SITU GASIFICATION/EFFICIENCY
Report on the successful development of underground coal gasification at Hanna, Wyoming (17 refs), 2:55562 (CONF-770510-8)
IN-SITU GASIFICATION/ENVIRONMENTAL IMPACTS
Underground gasification offers clean safe route to coal energy, 2:56962
IN-SITU GASIFICATION/FEASIBILITY STUDIES
Underground coal gasification (13 refs), 2:55588
IN-SITU GASIFICATION/GROUND SUBSIDENCE
Ground subsidence resulting from underground gasification of coal (36 refs), 2:55584 (UCRL-5225)
Problems solved and problems not solved in UCG, 2:55560 (CONF-770510-6)
IN-SITU GASIFICATION/INDUCTION LOGGING
Remote sensing of an underground coal-burn cavity with a wide-band induction system, 2:55591
IN-SITU GASIFICATION/PRODUCTIVITY
Report on the successful development of underground coal gasification at Hanna, Wyoming (17 refs), 2:55562 (CONF-770510-8)
IN-SITU GASIFICATION/REMOTE SENSING
Remote sensing of an underground coal-burn cavity with a wide-band induction system, 2:55591
IN-SITU GASIFICATION/RESEARCH PROGRAMS
Underground coal gasification program (Overview of ERDA program), 2:55566 (ERDA-77-51)
IN-SITU GASIFICATION/VARIATIONS
Problems solved and problems not solved in UCG, 2:55560 (CONF-770510-6)
INSOLATION/DATA ACQUISITION
Analysis of the California solar resource, 2:56138
INTERFACES/CRACKS
Segregation induced embrittlement of grain interfaces, 2:57111 (COO-3084-52)
INTERFACES (EQUIPMENT)
See EQUIPMENT INTERFACES
INTERMEDIATE BOSONS/PARTICLE PRODUCTION
Results of the search for the intermediate W boson in proton-nucleus collisions at 70 GeV, 2:57565
INTERNAL COMBUSTION ENGINES
See also DIESEL ENGINES
STRATIFIED CHARGE ENGINES
INTERNAL COMBUSTION ENGINES/AIR CLEANING
Centrifugal air precleaner for internal combustion engines (Patent), 2:57049
INTERNAL COMBUSTION ENGINES/AIR HEATERS
Intake air heating device for use in internal combustion engine (Patent), 2:57050
INTERNAL COMBUSTION ENGINES/COMBINED CYCLES
Characteristics of the working cycle of a turbopiston internal combustion engine, 2:57060
INTERNAL COMBUSTION ENGINES/FLOW MODELS
Calculation of the non-steady gas exchange process in internal combustion engines, 2:57051
INTERNAL COMBUSTION ENGINES/FUEL SYSTEMS
Air-fuel ratio regulating apparatus for an internal combustion engine with exhaust gas sensor characteristic compensation (Patent), 2:57081
Water injection device for internal combustion engines (Patent), 2:57079
INTERNAL COMBUSTION ENGINES/FUEL-AIR RATIO
Air-fuel ratio control system for use with internal combustion engine (Patent), 2:57084
INTERNAL COMBUSTION ENGINES/FUELS
Numerical evaluation of thermodynamic equilibrium states for gas mixtures, 2:57245
INTERNAL COMBUSTION ENGINES/GAS FLOW
Calculation of the non-steady gas exchange process in internal combustion engines, 2:57051
INTERNAL COMBUSTION ENGINES/HEAT TRANSFER
Determination of the effective depth of hot junction of surface thermocouples when investigating nonsteady heat transfer in an internal combustion engine, 2:57052
INTERNAL COMBUSTION ENGINES/POLLUTION CONTROL EQUIPMENT
Air-fuel ratio regulating apparatus for an internal combustion engine with exhaust gas sensor characteristic compensation (Patent), 2:57081
Water injection device for internal combustion engines (Patent), 2:57079
INTERNAL COMBUSTION ENGINES/THERMAL EFFICIENCY
Characteristics of the working cycle of a turbopiston internal combustion engine, 2:57060
INTERSTELLAR SPACE/MOLECULES
Interstellar molecule formation (Kinetics), 2:57487
INTERSTELLAR SPACE/RADIOISOTOPES
Al-26: a galactic source of gamma ray line emission (List of candidates for gamma emission), 2:57485 (N-77-16980)
INVESTMENT
Accommodation in the international capital markets and the recycling of oil funds. Working paper, 2:56917 (PB-265113)
IODINE 122/ISOTOPE PRODUCTION
^{122}Xe-^{122}I generator: a preliminary report, 2:57243 (BNL-22993)
IODINE 128/HOT ATOM CHEMISTRY
Gas to liquid to solid transition in halogen hot atom chemistry. IV. The suggestion of multiple enhancement reactions in high energy iodine-128-ethane systems, 2:57240
IODINE 129/ADSORPTION
Alternative fuel cycle technology progress report for April 1-June 30, 1977, 2:55900 (ICP-1122)
IODINE 131/REMOVAL
On-line separation of radioiodine in highly radioactive EBR-II sodium, 2:56512 (CONF-760503-P1)
ION ACOUSTIC WAVES/EXCITATION
Trapped particles and harmonic generation, 2:57675 (UCRL-13727)
ION ACOUSTIC WAVES/HARMONICS
Trapped particles and harmonic generation, 2:57675 (UCRL-13727)
ION ACOUSTIC WAVES/TRAPPING
Stability of a finite amplitude ion acoustic wave in plasmas, 2:57681
ION BEAM TYPE REACTORS
See I-BEAM TYPE REACTORS
ION COLLISIONS
See also ELECTRON-ION COLLISIONS
ION-ATOM COLLISIONS
ION-MOLECULE COLLISIONS
Important problems in future heavy ion atomic physics, 2:57557
ION COLLISIONS/EXCITATION
Electronic state alignment, orientation, and coherence produced by beam-foil collisions, 2:57499
ION COLLISIONS/REVIEWS
Analysis of electron correlations, 2:57518
ION IMPLANTATION
Ion implantation in metals, 2:57095 (SAND-77-0373)
ION IMPLANTATION/CONTROL SYSTEMS
System for controlling ion implantation dosage in electronic materials (Patent), 2:57184
ION MICROPROBE ANALYSIS
Profiling hydrogen and helium in materials using ion beams, 2:57338
ION SOURCES
See also ELECTRON BEAM ION SOURCES
ION SOURCES/DESIGN
Ion-storage collision technique (Review), 2:57500
ION SOURCES/PERFORMANCE
Ion-storage collision technique (Review), 2:57500

ION WAVES/PLASMA MICROINSTABILITIES
Nonlinear propagation of ion-cyclotron modes, 2:57666
ION WAVES/WAVE PROPAGATION
Nonlinear propagation of ion-cyclotron modes, 2:57666
ION-ATOM COLLISIONS/AUGER EFFECT
High-resolution x-ray and Auger electron measurements in ion-atom collisions (Review), 2:57541
ION-ATOM COLLISIONS/AUTOIONIZATION
Electron ejection in slow heavy particle collisions, 2:57535
ION-ATOM COLLISIONS/EXCITATION
Experimental studies of inner-shell excitation in slow ion-atom collisions, 2:57536
Impact parameter dependence of inner shell excitation (Review, coincidence methods), 2:57540
Optical emission in slow atomic collisions (Mechanisms optical methods, cross sections, threshold energy, multiplets, total and differential polarization), 2:57534
Theory of inner-shell excitation in slow ion-atom collisions (Cross sections, reviews, Schroedinger equation), 2:57537
ION-ATOM COLLISIONS/INNER-SHELL IONIZATION
Radiative and nonradiative electron capture from and into outer and inner shells in heavy ion-atom collisions (First Born approximation), 2:57543
ION-ATOM COLLISIONS/INTERATOMIC FORCES
Long-range interactions of ions with atoms having partially filled p subshells (Born-Oppenheimer approximation), 2:57513
ION-ATOM COLLISIONS/IONIZATION
Electron ejection in slow heavy particle collisions, 2:57535
Experimental studies of target and projectile X radiation in high velocity atomic collisions (Review, cross sections), 2:57538
Radiative and nonradiative electron capture from and into outer and inner shells in heavy ion-atom collisions (First Born approximation), 2:57543
ION-ATOM COLLISIONS/X-RAY SPECTRA
High-resolution x-ray and Auger electron measurements in ion-atom collisions (Review), 2:57541
ION-MOLECULE COLLISIONS/EXCITATION
Experimental evidence for anisotropy of non-characteristic x-rays (Review, cross sections), 2:57542
IONS/CHEMICAL REACTIONS
Application of ion cyclotron resonance spectroscopy, photoionization mass spectrometry and photoelectron spectroscopy to study the properties and reactions of ions in gases. Technical progress report, April 1, 1976-January 31, 1977, 2:57210 (CALT-767P8-7)
IONS/ENERGY LEVELS
Electronic state alignment, orientation, and coherence produced by beam-foil collisions, 2:57499
IONS/PHYSICAL RADIATION EFFECTS
Atomic collisions and fission technology, 2:57621
IONS/SLOWING-DOWN
Atomic collisions and fission technology, 2:57621
IOWA/COAL INDUSTRY
Economics of mining coal in Iowa (Economic climate in which coal industry competes), 2:55731 (IS-ICP-46)
IOWA/SURFACE MINING
Strip-mining and small mammals in southern Iowa (36 refs), 2:55671 (IS-ICP-44)
IRAN-1 REACTOR/CONSTRUCTION
Iran-1 and Iran-2 nuclear power station on the Persian Gulf, 2:56413
IRAN-2 REACTOR/CONSTRUCTION
Iran-1 and Iran-2 nuclear power station on the Persian Gulf, 2:56413
IRON/ENVIRONMENTAL TRANSPORT
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)
IRON/MICROSTRUCTURE
Microstructural effects in abrasive wear. Quarter progress report, 15 March 1977-15 June 1977, 2:57104 (COO-4246-1)
IRON/MUON REACTIONS
Inelastic interaction of muons with Fe nuclei at small Q^2 in the energy region above 200 GeV, 2:57596
IRON/NEUTRON REACTIONS
Comments on the energy-averaged total neutron cross sections of structural materials in the few MeV range, 2:57591 (ANL/NDM-33)
IRON/NUCLEOSYNTHESIS
Relative abundances of elements in main-sequence stars, and nucleosynthesis, 2:57479
IRON/PHOTONUCLEAR REACTIONS
Inelastic interaction of muons with Fe nuclei at small Q^2 in the energy region above 200 GeV, 2:57596
IRON/WEAR RESISTANCE
Microstructural effects in abrasive wear. Quarter progress report, 15 March 1977-15 June 1977, 2:57104 (COO-4246-1)
IRON 55/RADIOECOLOGICAL CONCENTRATION
Vertical distribution of ^{55}Fe in the ocean, 2:57399 (RLO-2231-T1-9)
IRON 56/NUCLEAR MAGNETIC RESONANCE
NMR and Moessbauer studies of the amorphous system Fe$_{70}$P/sub 21-x/B/sub x/, 2:57101 (CALT-822-95)
IRON 57/NUCLEAR MAGNETIC RESONANCE
NMR and Moessbauer studies of the amorphous system Fe$_{70}$P/sub 21-x/B/sub x/, 2:57101 (CALT-822-95)
IRON ALLOYS
See also INCONEL 600
IRON BASE ALLOYS
STEELS
IRON ALLOYS/COMPATIBILITY
Compatibility of bismuth and bismuth-lithium solutions with refractory metals and graphite, 2:57108 (CONF-760503-P2)
IRON ALLOYS/CORROSIVE EFFECTS
Corrosion of iron-base alloys by lithium, 2:57134 (CONF-760503-P2)
IRON ALLOYS/CURIE POINT
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
IRON ALLOYS/ELECTRIC CONDUCTIVITY
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
IRON ALLOYS/MAGNETIC MOMENTS
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
IRON ALLOYS/MAGNETIZATION
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
IRON ALLOYS/PHYSICAL RADIATION EFFECTS
Short-range order in disordered Fe-Ni alloys investigated by time-dependent perturbed angular correlation technique (Fast neutrons), 2:57144
IRON BASE ALLOYS/AGING
Characterization and aging kinetics study of gamma prime strengthened Fe-Cr-Ni experimental alloys for breeder reactors, 2:57119 (WARD-AD-3045-5)
IRON BASE ALLOYS/CURIE POINT
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
IRON BASE ALLOYS/ELECTRIC CONDUCTIVITY
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
IRON BASE ALLOYS/MAGNETIC MOMENTS
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
IRON BORIDES/HYPERFINE STRUCTURE
NMR and Moessbauer studies of the amorphous system Fe$_{70}$P/sub 21-x/B/sub x/, 2:57101 (CALT-822-95)
IRON CHLORIDES/CORROSIVE EFFECTS
High temperature corrosion in the thermochemical hydrogen production from nuclear heat, 2:55975
IRON COMPLEXES/NEUTRON DIFFRACTION
Neutron diffraction studies of tetrahedral cluster transition metal hydride complexes: $HFeCo_3(CO)_9(P(OCH_3)_3)_3$ and $H_3Ni_4(C_5H_5)_4$, 2:57209 (BNL-22982)
IRON IONS/ELECTRON SPIN RESONANCE
Transmission electron spin resonance in dilute CuFe alloys, 2:57103 (COO-3150-39)
IRON ORES/PELLETIZING
Utilization of low and intermediate Btu gas from coal for iron ore pelletizing. Open file report, Jul 1975-Mar 1977, 2:57094 (PB-264702)
IRON ORES/REDUCTION
Prereduction of iron ore (17 refs), 2:55667
IRON PHOSPHIDES/HYPERFINE STRUCTURE
NMR and Moessbauer studies of the amorphous system Fe$_{70}$P/sub 21-x/B/sub x/, 2:57101 (CALT-822-95)
IRRADIATION REACTORS
(For isotope production and irradiation purposes; for producing fissile materials see PRODUCTION REACTORS.)
IRRADIATION REACTORS/TABLES
Nuclear reactors built, being built, or planned in the United States as of June 30, 1977, 2:56362 (TID-8200-R36)
IRRIGATION/SOLAR WATER PUMPS
Solar energy applications in agriculture: potential, research needs, and adoption strategies, 2:56092 (PB-265105)
ISOMERIZATION
See CHEMICAL REACTIONS
ISOTOPE APPLICATIONS
See also TRACER TECHNIQUES
ISOTOPE APPLICATIONS/REVIEWS
Survey of large-scale isotope applications: nuclear technology field, 2:55969 (MLM-2391)

ISOTOPE EFFECTS/BORN-OPPENHEIMER APPROXIMATION
Corrections to the Born-Oppenheimer approximation in the calculation of iotope effects on equilibrium constants, 2:57223
ISOTOPE EFFECTS/MEETINGS
Isotopes and chemical principles, 2:57224
ISOTOPE EFFECTS/QUANTUM MECHANICS
Quantum mechanical foundations of isotope chemistry, 2:57225
ISOTOPE EFFECTS/SPECTROSCOPY
Isotope effects and spectroscopy, 2:57205
ISOTOPE EFFECTS/STATISTICAL MECHANICS
Quantum mechanical foundations of isotope chemistry, 2:57225
ISOTOPIC EXCHANGE/PARTITION FUNCTIONS
Electrochemical determination of equilibrium constants for isotope-exchange reactions, 2:57228
ITALY/PUMPED STORAGE POWER PLANTS
Pumped storage hydroelectric plants, 2:56885

J

JAPAN
Petropolitics and the Atlantic Alliance (Short- and long-term effects of petroleum crisis), 2:56969 (AD-A-037807)
JAPAN/GEOPHYSICAL SURVEYS
Reproducibility of the distribution of the underground temperature at one meter depth and one verified example of the availability of underground temperature survey, 2:56186
JAPAN/GEOTHERMAL ENERGY
Utilization of geothermal energy other than power generation, 2:56205
JAPAN/GEOTHERMAL EXPLORATION
Ground temperature surveys and thermal discharge measurements at Ibusuki and its surrounding geothermal areas, 2:56185
Heat discharge measurement and geophysical prospecting at Nigorikawa basin, northern part of Komagatake, 2:56183
Total heat discharge from northern Azuma geothermal area, 2:56184
JAPAN/GEOTHERMAL FIELDS
Geothermal resources, 2:56176
Ground temperature surveys and thermal discharge measurements at Ibusuki and its surrounding geothermal areas, 2:56185
Total heat discharge from northern Azuma geothermal area, 2:56184
JAPAN/GEOTHERMAL POWER PLANTS
Geothermal resources, 2:56176
JAPAN/GEOTHERMAL RESOURCES
Geothermal resources, 2:56176
JAPAN/HOT SPRINGS
Antimony content in the hot spring waters in Gunma Prefecture, 2:56190
Boric acid content of hot springs and river waters at Owakudani Valley, Volcano Hakone, 2:56192
Calcium chloride springs of sea water origin in Toi Hot Spring, 2:56191
Determination of trace elements in hot spring water by anode stripping voltametry, 2:56211
Geothermal resources, 2:56176
JAPAN/RIVERS
Boric acid content of hot springs and river waters at Owakudani Valley, Volcano Hakone, 2:56192
JAPAN/SEISMIC SURVEYS
Seismometrical observation in Hakone volcano, 1973, 2:56188
JAPAN/THERMAL WATERS
Observation of temperature and water level in Hakone volcano, 1973, 2:56179
JAPAN/VOLCANOES
Observation of a newly appeared active fumarole at Owakudani, Hakone volcano, 2:56180
Seismometrical observation in Hakone volcano, 1973, 2:56188
JAPAN ATR FUGEN
See JATR REACTOR
JATR REACTOR/PRESSURE VESSELS
Outline of manufacturing and installation experience of pressure vessel structure for the prototype heavy water moderated, boiling light water cooled reactor FUGEN, 2:56466
JATR REACTOR/REACTOR CHARGING MACHINES
Development on the refueling machine for prototype advanced thermal reactor 'Fugen', 2:56468
JEMEZ MOUNTAINS/GEOTHERMAL GRADIENTS
Subsurface temperature data in Jemez Mountains, New Mexico. Circular 151, 2:56182 (NP-22280)
JEMEZ MOUNTAINS/HEAT FLOW
Subsurface temperature data in Jemez Mountains, New Mexico. Circular 151, 2:56182 (NP-22280)
JOSEPHSON JUNCTIONS/ELECTRIC CURRENTS
Natural fluctuations of the tunnel current in Josephson junctions, 2:57266
JUICES
See BEVERAGES

K

KALKAR POWER REACTOR
See SNR-1 REACTOR
KANSAS/GEOLOGICAL SURVEYS
Seismicity and tectonic relationships of the Nemaha Uplift in Oklahoma, Kansas, and Nebraska, 2:57473
KAON PLUS-PROTON INTERACTIONS/ELASTIC SCATTERING
Elastic π^+ p, K^+ p, and pp scattering in the region of Coulomb-nuclear interference at momenta 42.5 and 52.2 GeV/c, 2:57569
KAON PLUS-PROTON INTERACTIONS/TOTAL CROSS SECTIONS
Elastic π^+ p, K^+ p, and pp scattering in the region of Coulomb-nuclear interference at momenta 42.5 and 52.2 GeV/c, 2:57569
KAON-DEUTERON INTERACTIONS/KNOCK-OUT REACTIONS
Contributions to the theory of isobar knockout from a deuteron, 2:57585
KARLSRUHE RESEARCH REACTOR FR-2
See FR-2 REACTOR
KERNKRAFTWERK OBRIGHEIM
See OBRIGHEIM REACTOR
KERNKRAFTWERK RWE-BAYERNWERK
See RWE-BAYERNWERK REACTOR
KEROGEN/CHEMICAL COMPOSITION
Contribution of different chemical functions in the 1710, 1630, and 3,430 cm^{-1} infrared absorption bands of kerogens, 2:55845
Nitrogenous substances of kerogen in Estonian dictyonemic shales, 2:55846
KEROGEN/INFRARED SPECTRA
Contribution of different chemical functions in the 1710, 1630, and 3,430 cm^{-1} infrared absorption bands of kerogens, 2:55845
KEROSENE/COMBUSTION
High temperature coal and slurry combustor according to a one-dimensional flow model, 2:55722 (CONF-770530-2)
KETONES/CHEMICAL REACTION KINETICS
Reaction of Type II biradicals with paraquat ions. Measurement of biradical lifetimes, 2:57230
KETONES/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
KINK INSTABILITY/INSTABILITY GROWTH RATES
Experimental and numerical studies of magnetohydrodynamic stability properties of a rectangular-cross-section finite-β toroidal plasma, 2:57671
KNK REACTOR/PRIMARY COOLANT CIRCUITS
Sorption of radionuclides on sodium sampling vessels, 2:56754 (CONF-760503-P1)
KOMPAKTE NATRIUMGEKUEHLTE REAKTOR
See KNK REACTOR
KOZLODUY-1 REACTOR/REACTOR OPERATION
Translations on Eastern Europe, 2:56410 (JPRS-69404)
KOZLODUY-2 REACTOR/REACTOR OPERATION
Translations on Eastern Europe, 2:56410 (JPRS-69404)
KRB REACTOR
See RWE-BAYERNWERK REACTOR
KRYPTON/MOLECULE-MOLECULE COLLISIONS
Study of momentum transfer distributions in rotationally inelastic collisions (Peripheral collisions, anisotropy), 2:57551
KRYPTON 86 REACTIONS/DEEP INELASTIC SCATTERING
Angular-momentum transfer in deeply inelastic scattering of 610-MeV ^{86}Kr by ^{209}Bi (Angular correlations of fragments from fissioning heavy reaction products), 2:57599
KRYPTON 86 REACTIONS/FISSION
Angular-momentum transfer in deeply inelastic scattering of 610-MeV ^{86}Kr by ^{209}Bi (Angular correlations of fragments from fissioning heavy reaction products), 2:57599
KRYPTON 86 REACTIONS/FUSION REACTIONS
Fusion in Kr-bombardments of medium-mass nuclei, 2:57597 (CONF-770115-1)
KS-150 REACTOR
See BOHUNICE A-1 REACTOR
KWO REACTOR
See OBRIGHEIM REACTOR

L

LABYRINTH
See AUDITORY ORGANS
LAGRANGIAN FIELD THEORY/RADIATIVE CORRECTIONS
Radiative corrections to the classical Lagrangian and dynamical symmetry breaking, 2:57587
LAGRANGIAN FIELD THEORY/SYMMETRY BREAKING
Radiative corrections to the classical Lagrangian and dynamical symmetry breaking, 2:57587
LAMINAR FLOW/STABILITY
Determination of the stability boundary of a laminar flow of steam with film boiling, 2:57300
LAMINOGRAPHY
See TOMOGRAPHY
LAND FILLS
See SANITARY LANDFILLS
LAND USE/AVAILABILITY
Energy and natural resources, 2:56930
LAND USE/ECONOMIC IMPACT
Land use-energy simulation model: a computer-based model for exploring land use and energy relationships, 2:56915 (BNL-50634)
LAND USE/ENVIRONMENTAL IMPACTS
Land use-energy simulation model: a computer-based model for exploring land use and energy relationships, 2:56915 (BNL-50634)
LAND USE/SOCIAL IMPACT
Land use-energy simulation model: a computer-based model for exploring land use and energy relationships, 2:56915 (BNL-50634)
LANTHANUM/EMISSION SPECTRA
Complete resolution of hyperfine structure in the close doublet λ5930.6 of ^{139}La by laser-atomic-beam spectroscopy, 2:57504
LANTHANUM/HYPERFINE STRUCTURE
Complete resolution of hyperfine structure in the close doublet λ5930.6 of ^{139}La by laser-atomic-beam spectroscopy, 2:57504
LANTHANUM/ION-ATOM COLLISIONS
Study of K, L, and M inner-shell ionization by proton impact (Total cross sections, 150 to 500 Kev, Born approximation), 2:57539
LANTHANUM COMPLEXES/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance studies of diamagnetic metal-aminopolycarboxylate complexes, 2:57229
LANTHANUM TELLURIDES/ELECTRIC CONDUCTIVITY
High-temperature thermal conductivity of La_3Te_4, 2:57180
LANTHANUM TELLURIDES/THERMAL CONDUCTIVITY
High-temperature thermal conductivity of La_3Te_4, 2:57180
LANTHANUM TELLURIDES/THERMOELECTRIC PROPERTIES
High-temperature thermal conductivity of La_3Te_4, 2:57180
LASER FUSION REACTORS
Comparative study of exploratory reactor concepts for inertial confinement fusion, 2:57779
Laser-fusion concept using D-D-T pellets with the DNP laser feedback system, 2:57767 (COO-2007-82)
LASER FUSION REACTORS/ACCIDENTS
Preliminary assessment of potential accidents of laser fusion electric generation stations, 2:57764
LASER FUSION REACTORS/BREEDING BLANKETS
First wall and blanket design for an ICTR, 2:57781
LASER FUSION REACTORS/COST
Laser fusion hybrid reactor systems study, 2:57769 (UCRL-13720)
LASER FUSION REACTORS/DESIGN
Conceptual approach to laser fusion hybrid reactor, 2:57778
Laser fusion hybrid reactor systems study, 2:57769 (UCRL-13720)
LASER FUSION REACTORS/FIRST WALL
First wall and blanket design for an ICTR, 2:57781
LASER FUSION REACTORS/HAZARDS
Preliminary assessment of potential accidents of laser fusion electric generation stations, 2:57764
LASER FUSION REACTORS/HEAT TRANSFER
Heat transfer and stress problems associated with ICTR walls, 2:57782
LASER FUSION REACTORS/PLASMA DIAGNOSTICS
Subpicosecond proximity-focused streak camera for x-ray and visible light, 2:57643
Ultrafast x-ray diagnostics for laser fusion experiments, 2:57644
LASER FUSION REACTORS/POWER GENERATION
Inertial confinement fusion reactor and generating station concepts, 2:57774
LASER FUSION REACTORS/RADIATION HAZARDS
Preliminary assessment of potential accidents of laser fusion electric generation stations, 2:57764
LASER FUSION REACTORS/RESEARCH PROGRAMS
Inertial confinement fusion program, 2:57773
Laser fusion technology and experiments, 2:57775
LASER FUSION REACTORS/THERMAL STRESSES
Heat transfer and stress problems associated with ICTR walls, 2:57782
LASER FUSION REACTORS/THERMONUCLEAR REACTOR COOLING SYSTEMS
Liquid-lithium waterfall inertial confinement fusion reactor concept, 2:57747
LASER IMPLOSIONS/ENERGY TRANSFER
Experimental simulation of parametric instabilities in laser-plasma interactions. Interim report, 2:57766 (AD-A-037761)
Theoretical interpretation of angle- and polarization-dependent laser light absorption measurements, 2:57772 (UCRL-79628)
LASER IMPLOSIONS/REVIEWS
Laser fusion implosion and target interaction physics, 2:57771 (UCRL-79540)
LASER ISOTOPE SEPARATION
Atomic collisions and fission technology, 2:57621
LASER RADIATION/FOCUSING
Geometrical theory of nonlinear phase distortion of intense laser beams, 2:57286 (UCRL-76834)
LASER RADIATION/WAVE PROPAGATION
Optical pulse squaring effects in a dispersive delay line, 2:57768 (NRL-MR-3525)
LASER-PRODUCED PLASMA/ELECTRIC POTENTIAL
Charge separation and target voltages in laser-produced plasmas, 2:57651
LASER-PRODUCED PLASMA/ENERGY TRANSFER
Experimental simulation of parametric instabilities in laser-plasma interactions. Interim report, 2:57766 (AD-A-037761)
Interaction of TEA CO_2 laser light with laser produced plasma, 2:57656
LASER-PRODUCED PLASMA/FAR ULTRAVIOLET RADIATION
Absolute measurements of photon flux from a laser plasma in the vacuum ultraviolet, 2:57657
LASER-PRODUCED PLASMA/SPATIAL DISTRIBUTION
Three-dimensional structure of the spread of laser-produced plasma consisting of aluminium ions and nuclei, 2:57784
LASER-PRODUCED PLASMA/WAVE PROPAGATION
Backscatter and beam refraction in underdense gas breakdown with nanosecond CO_2 laser, 2:57683
Upper-hybrid-resonance absorption of laser radiation in a magnetized plasma, 2:57686
LASERS
See also CARBON DIOXIDE LASERS
CARBON MONOXIDE LASERS
DYE LASERS
GAS LASERS
SEMICONDUCTOR LASERS
SOLID STATE LASERS
LASERS/FABRICATION
The development of visible molecular lasers. Final report, 2:57282 (AD-A-037488)
LATENT HEAT STORAGE/ALLOYS
Thermal storage in metals, 2:56160
LATENT HEAT STORAGE/CONCRETES
Thermocrete heat storage materials: applications and performance specifications, 2:56167
LATENT HEAT STORAGE/COST
Immiscible fluid: heat of fusion energy storage system, 2:56168
Thermal energy storage with saturated aqueous solutions, 2:56165
LATENT HEAT STORAGE/MATERIALS
Inorganic phase change materials for energy storage in solar thermal program ($NaNO_3$ and NaOH mixture), 2:56158
LATENT HEAT STORAGE/RESEARCH PROGRAMS
Demand sensitive energy storage in molten salts, 2:56157
LATENT HEAT STORAGE/TECHNOLOGY ASSESSMENT
High temperature thermal energy storage (124 references), 2:56154
LATTICES (CRYSTAL)
See CRYSTAL LATTICES
LATTICES (REACTOR)
See REACTOR LATTICES
LEAD/X-RAY FLUORESCENCE ANALYSIS
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57198 (LA-6869-MS)
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57197 (LA-6869)
LEAD 204 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
LEAD 206 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
LEAD 207 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600

LEAD 208 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
LEAD ORES/RESERVES
Canadian reserves of seven metals, 2:56933
LEAD-ACID BATTERIES/BATTERY SEPARATORS
Current trends in battery separators, 2:56904
LEAD-ACID BATTERIES/CATHODES
Lead storage battery electrode and method (Patent; lacquer coating to reduce peak effect in tube-type plates), 2:56901
LEAD-ACID BATTERIES/DESIGN
Gould Drynamic battery (Plates and separators are moist), 2:56894
LEAD-ACID BATTERIES/GRIDS
Lead calcium grid casting, 2:56907
Maintenance free batteries: evolution or revolution, 2:56905
LEAD-ACID BATTERIES/HEALTH HAZARDS
ILZRO health studies, 2:56895
LEAD-ACID BATTERIES/MARKET
Replacement battery. Industry forecast 1975-1979, a report by the BCI Statistical Committee, 2:56892
LEAD-ACID BATTERIES/MATERIALS RECOVERY
Recovery of lead from battery scrap (Patent), 2:56891
LEAD-ACID BATTERIES/MEETINGS
Battery Council International convention: 1975 (Hollywood-by-the-Sea, Florida), 2:56889
LEAD-ACID BATTERIES/METALLURGICAL EFFECTS
Tin and bismuth in lead-calcium alloy (Metallurgical effects), 2:56906
LEAD-ACID BATTERIES/PERFORMANCE TESTING
Actual service life and bench cycle life of lead-acid battery for electric vehicle use, 2:56900
LEAD-ACID BATTERIES/PRODUCTION
Environmental control problems, 2:56896
LEAK DETECTORS/DESIGN
Leakage detecting apparatus in an atomic power plant (Patent), 2:56703
LEAK DETECTORS/RESEARCH PROGRAMS
IGT experience in leak detection methodology and systems, 2:55818 (NP-22364)
LENS (CRYSTALLINE)
See CRYSTALLINE LENS
LEPTON-NUCLEON INTERACTIONS
See also LEPTON-PROTON INTERACTIONS
LEPTON-NUCLEON INTERACTIONS/WEAK NEUTRAL CURRENTS
Polarization phenomena in isobar production by a weak neutral current, 2:57577
LEPTON-PROTON INTERACTIONS/DEEP INELASTIC SCATTERING
Deep-inelastic scattering of leptons by virtual particles, 2:57574
LEUKEMIA/RADIOINDUCTION
Radiation carcinogenesis. Progress report IV, 15 March 1976-15 May 1977 (Abscopal effects of radiation on parabiant rats), 2:57435 (COO-3017-31)
LEVEL INDICATORS/DESIGN
Method of detecting and correcting reactor water level (Patent; BWR), 2:56406
LI-DRIFTED GE DETECTORS/PERFORMANCE
Ge(Li) system for the monitoring of low level radioactive gases, 2:57332
LI-DRIFTED GE DETECTORS/SPECIFICATIONS
Ge(Li) system for the monitoring of low level radioactive gases, 2:57332
LIMESTONE/MATERIALS HANDLING
Coal mine-coal conversion plant interface evaluation and conceptual design. Phase II. Monthly technical progress report, 1 April-30 April 1977, 2:55582 (FE-2370-13)
LINEAR THETA PINCH DEVICES/CONFINEMENT TIME
Evolution and thermonuclear yield of a high β plasma column, 2:57631
LINEAR THETA PINCH DEVICES/FUSION YIELD
Evolution and thermonuclear yield of a high β plasma column, 2:57631
LIQUEFIED NATURAL GAS/INTERCHANGEABILITY
Peak-shaving with Groningen natural gas, 2:55812
LIQUEFIED NATURAL GAS/PRODUCTION
Natural-gas liquefaction by an expansion-turbine mixture cycle, 2:55813
LIQUEFIED NATURAL GAS/TRADE
Status of world trade in liquefied natural gas, 2:55814 (CONF-770360-1)
LIQUEFIED NATURAL GAS/TRANSPORT
Ocean transport and storage of liquefied natural gas, 2:55823
Transportation of liquids (Patent; pipelines operated between -200 and -120°F), 2:55819
LIQUID ASPHALT
See RESIDUAL FUELS
LIQUID FUELS/ATOMIZATION
Preparation of liquid fuels by gas atomization, 2:57317
LIQUID FUELS/COMBUSTION
Mathematical model to study the process of combustion of a stream of atomized liquid fuel as a control object, 2:57322
LIQUID FUELS/SYNTHESIS
Pyrolysis process for converting refuse to fuel gas (Patent; optimization of Purox Pyrolysis Process), 2:55993
LIQUID METAL FAST BREEDER REACTORS
See LMFBR TYPE REACTORS
LIQUID METALS/EQUATIONS OF STATE
Metallic high pressure equation-of-state derived from experimental data, 2:57106 (UCRL-79032)
LIQUID METALS/MEETINGS
Proceedings of the international conference on liquid metal technology in energy production, 2:56477 (CONF-760503-P1)
Proceedings of the international conference on liquid metal technology in energy production, 2:56529 (CONF-760503-P2)
LIQUID METALS/PUMPING
Distribution of the density of induced current along the height of an operational duct on an electrodynamic pump, 2:57306
LIQUID METALS/WETTING AGENTS
Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R-1746)
LIQUID METAL-WATER REACTIONS
See MOLTEN METAL-WATER REACTIONS
LIQUID-METAL MHD GENERATORS/TWO-PHASE FLOW
Some results of investigation of pressure pulsations in a condensing injector, 2:56998
LIQUID-METAL MHD GENERATORS/VAPOR JET EJECTORS
Some results of investigation of pressure pulsations in a condensing injector, 2:56998
LITHIUM/ACTIVATION ANALYSIS
Determination of oxygen in reactive materials by 14-MeV neutron activation analysis, 2:57193
LITHIUM/COMPATIBILITY
Compatibility of bismuth and bismuth-lithium solutions with refractory metals and graphite, 2:57108 (CONF-760503-P2)
LITHIUM/CORROSIVE EFFECTS
Corrosion of ferrous alloys in nitrogen contaminated liquid lithium, 2:57133 (CONF-760503-P1)
LITHIUM/ION COLLISIONS
Trapping efficiency of molten lithium for 20-keV tritium ions, 2:57497
LITHIUM/SOLVENT PROPERTIES
Solubility of lithium oxide in liquid lithium (195 to 734°C), 2:57131
LITHIUM 6 REACTIONS
Cross section for the production of ^{7}Be from ^{6}Li, ^{6}Li interactions, 2:57592
LITHIUM 6 TARGET/LITHIUM 6 REACTIONS
Cross section for the production of ^{7}Be from ^{6}Li, ^{6}Li interactions, 2:57592
LITHIUM ALLOYS/CORROSIVE EFFECTS
Corrosion of iron-base alloys by lithium, 2:57134 (CONF-760503-P2)
LITHIUM HYDROXIDES/ELECTRIC CONDUCTIVITY
Lithium ion conductive electrolyte composition (Patent), 2:56902 (SAND-77-6009)
LITHIUM HYDROXIDES/FABRICATION
Lithium ion conductive electrolyte composition (Patent), 2:56902 (SAND-77-6009)
LITHIUM IODIDES/ELECTRIC CONDUCTIVITY
Lithium ion conductive electrolyte composition (Patent), 2:56902 (SAND-77-6009)
LITHIUM IODIDES/FABRICATION
Lithium ion conductive electrolyte composition (Patent), 2:56902 (SAND-77-6009)
LITHIUM ISOTOPES/ISOTOPIC EXCHANGE
Electrochemical determination of equilibrium constants for isotope-exchange reactions, 2:57228
LITHIUM OXIDES/SOLUBILITY
Solubility of lithium oxide in liquid lithium (195 to 734°C), 2:57131
LITHIUM SULFATES/ELECTRIC CONDUCTIVITY
Lithium ion conductive electrolyte composition (Patent), 2:56902 (SAND-77-6009)
LITHIUM SULFATES/FABRICATION
Lithium ion conductive electrolyte composition (Patent), 2:56902 (SAND-77-6009)
LITHIUM-WATER-AIR BATTERIES/DESIGN
Researchers study new batteries, 2:56899
LITHIUM-WATER-AIR BATTERIES/PERFORMANCE TESTING
Researchers study new batteries, 2:56899
LIVER/ZINC 65
Binders of intravenously administered 65-zinc in rat liver cytoplasm, 2:57440 (N-77-16683)
LIVESTOCK
See DOMESTIC ANIMALS
LMFBR TYPE REACTORS
See also BOR-60 REACTOR

CLINCH RIVER BREEDER REACTOR
EBR-2 REACTOR
FFTF REACTOR
MONJU REACTOR
PFR REACTOR
PHENIX REACTOR
RAPSODIE REACTOR
SBR-5 REACTOR
SNR-1 REACTOR

LMFBR TYPE REACTORS/AIR CLEANING SYSTEMS
Containers for radioactive aerosols (Patent; LMFBR), 2:56571

LMFBR TYPE REACTORS/BALL BEARINGS
Experimental investigations of the frictional and wear behavior of tungsten carbide cermet ball bearings under axial load in liquid sodium, 2:56495 (CONF-760503-P1)
Wear of rolling element bearings in sodium, 2:56497 (CONF-760503-P1)

LMFBR TYPE REACTORS/BREEDING RATIO
Breeding performance optimization of helium-bonded carbide fuel in 1500-MW(e) LMFBRs, 2:56549
Evaluation of LMFBR performance characteristics in the U.S. nuclear energy system, 2:56547

LMFBR TYPE REACTORS/COLD TRAPS
Improved method for operating sodium system cold traps, 2:56543

LMFBR TYPE REACTORS/CONTROL ELEMENTS
Examination of fast reactor fuels, FBR analytical quality assurance standards and methods, and analytical methods development: irradiation tests. Progress report, January 1-March 31, 1977 (UO_2; PuO_2), 2:56539 (LA-6808-PR)

LMFBR TYPE REACTORS/COOLANT CLEANUP SYSTEMS
Experience with sodium purification on large-scale operational test loops in France, 2:56487 (CONF-760503-P1)
Identification of impurities in sodium and its purification, 2:56488 (CONF-760503-P1)

LMFBR TYPE REACTORS/CORIUM
Natural convection in porous media with heat generation, 2:56801

LMFBR TYPE REACTORS/DESIGN
International Working Group on Fast Reactors ninth annual meeting, Vienna, Austria, 30 March-2 April 1976. Summary report: Part II and Part III, 2:56538 (IWGFR-12)
Operation of PFR and influence upon the design of CFR I, 2:56541 (TRG-Report-2819(D))

LMFBR TYPE REACTORS/ECONOMICS
Clinch River Breeder Reactor Plant technical review, 2:56534 (CRBRP-PMC-77-03)

LMFBR TYPE REACTORS/ELECTROMAGNETIC PUMPS
Electromagnetic induction pump (Patent; LMFBR), 2:56579

LMFBR TYPE REACTORS/EXCURSIONS
Comparison of the EPIC and PLUTO computer codes for TOP conditions, 2:56825
Effect of pellet density and axial restraint on failure threshold, 2:56854
Model to predict core pressure during a transient overpower (TOP), 2:56831
Parametric safety analyses for reduced energetics in PLBR-sized cores, 2:56824

LMFBR TYPE REACTORS/FIRES
Aerosol measurements and modeling for fast reactor safety. Task 7. Quarterly progress report, October 1-December 31, 1976, 2:56768 (BMI-NUREG-1969)

LMFBR TYPE REACTORS/FLOW BLOCKAGE
BOBL code. Experimental verification of the hydraulic model, including effects of pin bowing and grids, 2:56536 (ECN-9)

LMFBR TYPE REACTORS/FLUID FLOW
ORSLAP: a digital computer program for dynamic simulation of a multinode sodium loop during transients, 2:56788 (ORNL/TM-5322)

LMFBR TYPE REACTORS/FUEL ASSEMBLIES
Coolant mixing in LMFBR rod bundles and outlet plenum mixing transients. Progress report, December 1, 1976-February 28, 1977, 2:56531 (COO-2245-38)
Fuel assembly in a reactor (Patent; LMFBR), 2:56577

LMFBR TYPE REACTORS/FUEL CANS
Effect of liquid sodium thermochemical reactions with stainless steels on mechanical response, 2:56518 (CONF-760503-P1)
In-reactor corrosion behavior of stainless steel in high temperature sodium, 2:56523 (CONF-760503-P1)
Influence of sodium on the mechanical properties of fuel element cladding, 2:56519 (CONF-760503-P1)
Influence of dynamic sodium on the creep properties of stabilized austenitic steels, 2:56520 (CONF-760503-P1)

LMFBR TYPE REACTORS/FUEL CHANNELS
Apparatus for cooling a fuel replacing cell in a reactor (Patent; LMFBR), 2:56576

LMFBR TYPE REACTORS/FUEL CYCLE
Evaluation of LMFBR performance characteristics in the U.S. nuclear energy system, 2:56547
Feasibility of denatured LMFBRs, 2:56548

LMFBR TYPE REACTORS/FUEL ELEMENT CLUSTERS
Analysis on sodium boiling experiment in FFM bundle 3B, test 4, 2:56817
Coupling of the structural and coolant response in a single core subassembly model, 2:56839
Gamma heated subassembly for sodium boiling experiments, 2:56794 (TID-27639)

LMFBR TYPE REACTORS/FUEL ELEMENT FAILURE
Fuel rod mechanics and failure analysis. Eighteenth quarterly report, November-December 1976 and January 1977, 2:56776 (GEFR-13923-18)
Thermal radiation effects on subassembly wall failure in fast reactors, 2:56845

LMFBR TYPE REACTORS/FUEL ELEMENTS
Elaboration of methods for burn-up determinations of fast reactor fuel, 2:56570
Examination of fast reactor fuels, FBR analytical quality assurance standards and methods, and analytical methods development: irradiation tests. Progress report, January 1-March 31, 1977 (UO_2; PuO_2), 2:56539 (LA-6808-PR)
Simplified method of computing clad and fuel strain and stress during irradiation (KRESS code), 2:56560

LMFBR TYPE REACTORS/FUEL PELLETS
Fuels characterization in LMFBR, 2:56544

LMFBR TYPE REACTORS/FUEL PINS
BOBL code. Experimental verification of the hydraulic model, including effects of pin bowing and grids, 2:56536 (ECN-9)
Breeding performance optimization of helium-bonded carbide fuel in 1500-MW(e) LMFBRs, 2:56549
Development and testing of high-performance fuel pin simulators for boiling experiments in liquid metal flow, 2:56500 (CONF-760503-P1)
Influence of LMFBR fuel pin temperature profiles on corrosion rate (SS-316), 2:56524 (CONF-760503-P1)

LMFBR TYPE REACTORS/FUEL-CLADDING INTERACTIONS
Effect of pellet density and axial restraint on failure threshold, 2:56854

LMFBR TYPE REACTORS/FUEL-COOLANT INTERACTIONS
Mechanisms of vapor explosions. Technical progress report, October 1976-March 1977, 2:56532 (COO-2512-10)
Radiological assessment models. Tenth quarterly report, December 1976-February 1977, 2:56777 (GEFR-14034-10)

LMFBR TYPE REACTORS/LOSS OF FLOW
Acoustic analysis of TREAT LMFBR safety test R8, 2:56816
Multichannel cladding relocation model for loss-of-flow accidents in LMFBRs, 2:56853

LMFBR TYPE REACTORS/MEETINGS
Proceedings of the international conference on liquid metal technology in energy production, 2:56477 (CONF-760503-P1)
Proceedings of the international conference on liquid metal technology in energy production, 2:56529 (CONF-760503-P2)

LMFBR TYPE REACTORS/MELTDOWN
Flow regime of hydrodynamically unstable melting systems, 2:56836
Heat transfer from a pool of molten UO_2 to a concrete slab, 2:56835
Limits of stability of internally heated boiling pools, 2:56842
Material compatibility studies for PAHR incore molten pool experiments, 2:56838
Meltdown phase for an LMFBR loss of heat sink during shutdown, 2:56828
Natural-convective cooling of a bed of fuel debris, 2:56834
Role of condensation on dispersion of closed boiling UO_2 systems, 2:56843
Role of fission gas in development of the transition phase, 2:56841
Self-consistent normal fluid equation-of-state for (U,Pu)N, 2:56849

LMFBR TYPE REACTORS/NEUTRON ABSORBERS
Absorber materials for fast reactor control applications, 2:56723
Correlation for boron carbide helium release in fast reactors, 2:56724
Measurement of tritium retention in fast-neutron-irradiated boron carbide, 2:56725
Synthesis and fabrication of EuB_6, 2:56726

LMFBR TYPE REACTORS/PIPE FITTINGS
Creep-fatigue test of an elbow subjected to cyclic in-plane moment loading, 2:56558

LMFBR TYPE REACTORS/POWER DISTRIBUTION
Method of calculation of detailed power distribution in fuel assemblies, 2:56567

LMFBR TYPE REACTORS/PRIMARY COOLANT CIRCUITS
Experimental studies on sodium fires application to reactors, 2:56580 (NP-tr-1980)
Fission product measurements in the inpile fission product loop, 2:56514 (CONF-760503-P1)
Fission product deposition in a stainless steel sodium system, 2:56515 (CONF-760503-P1)
Reactor (Patent; LMFBR), 2:56574

Reactor (Patent; LMFBR), 2:56575
Reactor apparatus (Patent; LMFBR), 2:56573
LMFBR TYPE REACTORS/RADIOACTIVE AEROSOLS
Aerosol measurements and modeling for fast reactor safety. Task 7. Quarterly progress report, October 1-December 31, 1976, 2:56768 (BMI-NUREG-1969)
Aerosols in nuclear engineering, 2:56880
Containers for radioactive aerosols (Patent; LMFBR), 2:56571
LMFBR TYPE REACTORS/REACTOR ACCIDENTS
Aerosol attenuation in leakage paths, 2:56819
Comparison of 2D and 3D diffusion theory codes for transition-phase modeling of distorted subassemblies, 2:56778 (HEDL-TME-77-26)
Comparison of experimental data with COBRA-3M prediction for an LMFBR loss-of-piping-integrity transient, 2:56856
Correlation for the Leidenfrost temperature for spherical particles and its application to FCI analysis, 2:56857
Dynamic analysis of hydraulic pressure wave propagation in a plastically deforming pipe, 2:56840
Effect of humidity on the burning rate of sodium droplets, 2:56823
Hydrogen jet recombination under postulated LMFBR accident contitions, 2:56837
Sensitivity of radiological consequences to variations in aerosol parameters, 2:56820
Thermal radiation effects on subassembly wall failure in fast reactors, 2:56845
Unified model for fission gas release and sodium boiling in reactor coolant channel, 2:56826
LMFBR TYPE REACTORS/REACTOR COMPONENTS
Corrosion and tribological investigations of chromium carbide coatings for sodium cooled reactor applications, 2:56494 (CONF-760503-P1)
Development of low friction materials for LMFBR components, 2:56492 (CONF-760503-P1)
Friction and wear in liquid-metal systems: comparability problems of test results obtained from different test facilities, 2:56493 (CONF-760503-P1)
LMFBR TYPE REACTORS/REACTOR COOLING SYSTEMS
Computational technique for estimating corrosion product release in an LMFBR, 2:56513 (CONF-760503-P1)
Material effects in LMFBR sodium systems, 2:56517 (CONF-760503-P1)
Materials experience with large sodium loops and components, 2:56486 (CONF-760503-P1)
Metallurgical problems associated with large sodium loop operations, 2:56485 (CONF-760503-P1)
Operational techniques employed for the liquid sodium source term control loops, 2:56491 (CONF-760503-P1)
Radioactive corrosion product transport and control, 2:56511 (CONF-760503-P1)
Radiochemical measurement of mass transport in sodium, 2:56516 (CONF-760503-P1)
Sodium and cover gas chemistry in the high temperature sodium facility, 2:56489 (CONF-760503-P1)
Sodium characterization during the starting period of a sodium loop, 2:56490 (CONF-760503-P1)
LMFBR TYPE REACTORS/REACTOR CORE DISRUPTION
Aerosol measurements and modeling for fast reactor safety. Task 7. Quarterly progress report, October 1-December 31, 1976, 2:56768 (BMI-NUREG-1969)
Alternative accident scenario for LMFBR core disruption, 2:56830
Attenuation of radiological consequences from CDA's by radiation. Progress report, October 1, 1976-September 31, 1977, 2:56772 (COO-4040-1)
Boiling pool analysis during transition to the transition phase of core disruptive accidents in LMFBRs, 2:56844
Dynamics of large waves during molten cladding film relocation, 2:56852
Effect of radiative cooling on HCDA radiological consequences during buoyancy period, 2:56822
Evaporation kinetics of oxide fuels and their effect on the actinide redistribution in reactor fuel pins and on fuel vapor pressure under accident conditions, 2:56878 (EURFNR-1370)
Evaporation studies of liquid oxide fuel at very high temperatures using laser beam heating (LMFBR; UO_2), 2:56774 (EURFNR-1400)
First-generation model to predict particle-size distributions for condensed UO_2 vapor, 2:56821
Importance of the solification of fuel condensate, 2:56851
Natural convection in porous media with heat generation, 2:56801
Proposed model for vapor bubble-slug heat transfer during LMFBR HCDAs, 2:56846
Radiological assessment models. Tenth quarterly report, December 1976-February 1977, 2:56777 (GEFR-14034-10)
Vapor pressure equation-of-state in core disassmbly calculations, 2:56848
LMFBR TYPE REACTORS/REACTOR CORES
Detection of a partial blockage in a heterogeneous core, 2:56476 (ANL-CT-77-30)
Method to calculate the influence of gas bubbles in liquid-metal cooled reactors, 2:56561
Operational reliability evaluation of fast power reactor cores, 2:56569
Optimized method for orificing LMFBR cores, 2:56530 (CONF-770611-6)
THECA: a code system for 3-D thermohydraulic layout of fast reactors, 2:56537 (EURFNR-1437)
LMFBR TYPE REACTORS/REACTOR INTERNALS
Core components for a sodium cooling fast breeder (Patent), 2:56578
LMFBR TYPE REACTORS/REACTOR MATERIALS
Compatibility of structural materials with boiling potassium, 2:56528 (CONF-760503-P1)
Corrosion, transport, and deposition of stainless steel in liquid sodium, 2:56522 (CONF-760503-P1)
Corrosion of steels in liquid sodium, 2:56525 (CONF-760503-P1)
Corrosion and creep of pressurized stainless-steel tubes in liquid sodium at 873 and 973°K, 2:56542
Development of low friction materials for LMFBR components, 2:56492 (CONF-760503-P1)
Evaluation of cobalt and nickel base materials for sliding and static contact applications in a liquid metal fast breeder reactor, 2:56498 (CONF-760503-P1)
Friction and wear behavior of Colmonoy and Stellite alloys in sodium environment, 2:56496 (CONF-760503-P1)
Investigations into the self-welding behavior of metallic materials exposed to sodium (LMFBR; Inconel 718; Stellite), 2:56499 (CONF-760503-P1)
Low cycle fatigue testing in flowing sodium at elevated temperatures, 2:56521 (CONF-760503-P1)
Material effects in LMFBR sodium systems, 2:56517 (CONF-760503-P1)
Sodium environment effects to structural materials for fast reactors, 2:56540 (PNC-J-225-76-02)
Solubility of oxygen in liquid sodium: effect on interpretation of corrosion data, 2:56527 (CONF-760503-P1)
Thermodynamic and diffusion studies on corrosion of austenitic stainless steel in liquid sodium, 2:56526 (CONF-760503-P1)
LMFBR TYPE REACTORS/REACTOR PROTECTION SYSTEMS
Bayesian Zero-Failure (BAZE) reliability demonstration testing procedure for components of nuclear reactor safety systems, 2:56784 (LA-6813-MS)
LMFBR TYPE REACTORS/REACTOR SAFETY
Natural convection in porous media with heat generation, 2:56801
Use of reliability in the LMFBR industry, 2:56771 (CONF-770625-3)
LMFBR TYPE REACTORS/REACTOR VESSELS
Inelastic behavior of finite circular cylindrical shells, 2:56554
LMFBR TYPE REACTORS/RELIABILITY
Use of reliability in the LMFBR industry, 2:56771 (CONF-770625-3)
LMFBR TYPE REACTORS/SHIELDING
Where are we and where are we going in reactor shielding, 2:56651 (CONF-770401-5)
LMFBR TYPE REACTORS/SHIELDS
Experimental study on fast-neutron streaming through a grid-plate shield of a liquid-metal fast breeder reactor, 2:56564
LMFBR TYPE REACTORS/STEAM GENERATORS
Alloy 800 for liquid-metal fast breeder reactor steam generators, 2:56565
Calculation of wastage by small water leaks in sodium heated steam generators, 2:56506 (CONF-760503-P1)
Design correlation for pressure drops in coiled, once-through steam generators, 2:56562
Materials engineering issues, LMFBR steam generators, 2:56503 (CONF-760503-P1)
Qualification of Alloy 800 for sodium heated steam generators, 2:56505 (CONF-760503-P1)
Research, development and realization of sectional modular sodium heated steam generator, 2:56566
Small leak shutdown, location, and behavior in LMFBR steam generators, 2:56507 (CONF-760503-P1)
Small leak damage and protection systems in steam generators, 2:56508 (CONF-760503-P1)
Sodium and steam leak simulation studies for fluidized bed steam generators, 2:56510 (CONF-760503-P1)
Some problems of leaks in sodium-water steam generator, 2:56504 (CONF-760503-P1)
LMFBR TYPE REACTORS/TEST FACILITIES
Sodium and cover gas chemistry in the high temperature sodium facility, 2:56489 (CONF-760503-P1)

LMFBR TYPE REACTORS/TRANSIENTS
ORSLAP: a digital computer program for dynamic simulation of a multinode sodium loop during transients, 2:56788 (ORNL/TM-5322)
LMFBR TYPE REACTORS/VALVES
Door valve (Patent; LMFBR), 2:56572
LNG
See LIQUEFIED NATURAL GAS
LOCAL GALAXY
See MILKY WAY
LOCAL GOVERNMENT/TAXES
State taxation of mineral deposits and production. Final report (Western states), 2:56956 (PB-264575)
LOFT REACTOR/PRESSURIZERS
Effects of RELAP4/MOD5 modeling of the LOFT pressurizer, 2:56761
LOFT REACTOR/REACTOR EXPERIMENTAL FACILITIES
LOFT experiment operating specification. LOFT nonnuclear experiment series L-1. EOS Volume 1. Appendix A. Revision 2. Change No. L1-A-1, 2:56757 (TID-27663)
LOFT REACTOR/REACTOR OPERATION
LOFT experiment operating specification. LOFT nonnuclear experiment series L-1. EOS Volume 1. Appendix A. Revision 2. Change No. L1-A-1, 2:56757 (TID-27663)
LONGWALL MINING
See also COAL MINING
Extracting coal standing on pillars by modified longwall method, 2:55700
Investigation into strata behaviour around an experimental longwall caving face in Jharia coalfield, 2:55699
LONGWALL MINING/MINING EQUIPMENT
Dismantling and installation of longwall face with powered supports (3 refs), 2:55698
LONGWALL MINING/SEISMIC EFFECTS
Study of microseismic activity associated with a longwall coal mining operation using a near-surface array (7 refs), 2:55657
LOSS CONE INSTABILITY/INSTABILITY GROWTH RATES
Influence of strong inhomogeneities on high-frequency mirror-drift-cone and convective-loss-cone instabilities, 2:57667
LOSS OF COOLANT
Behavior of inner surface oxidation of the zircaloy cladding tube in a loss-of-coolant accident (BWR, PWR), 2:56783 (JAERI-M-6602)
Oxygen concentration distribution in β-phase of the Zry-4 cladding during Zr-steam reaction at LOCA (BWR, PWR), 2:56781 (JAERI-M-6538)
LOSS OF COOLANT/AFTER-HEAT
Analysis of LWR post-LOCA gamma ray energy redistribution, 2:56806
LOSS OF COOLANT/HYDRODYNAMICS
Steam-water mixing and system hydrodynamics program. Task 4. Quarterly progress report, October-December 1976 (PWR), 2:56767 (BMI-NUREG-1968)
LOSS OF COOLANT/MATHEMATICAL MODELS
Analysis of Standard Problem 2 with the TRAC-1D Code, 2:56812
HYDY-B1 CODE: calculational model for core thermo-hydraulics during a loss-of-coolant accident, 2:56782 (JAERI-M-6539)
LOSS OF COOLANT/TWO-PHASE FLOW
Calculation of the stationary mass velocity of steam mixtures and of the recoil forces occurring during LOCA, 2:56780 (IRS-W-24)
Steam-water mixing and system hydrodynamics program. Task 4. Quarterly progress report, October-December 1976 (PWR), 2:56767 (BMI-NUREG-1968)
LOSS OF FLOW
Multichannel cladding relocation model for loss-of-flow accidents in LMFBRs, 2:56853
LOSS OF FLOW/FUEL ELEMENT FAILURE
Acoustic analysis of TREAT LMFBR safety test R8, 2:56816
HTGR fuel failure in the absence of core cooling, 2:56802
LOSS OF FLUID TEST REACTOR
See LOFT REACTOR
LOW BTU GAS/CLEANING
High temperature turbine technology program. Phase I. Program and system definition. Topical report: fuels cleanup and turbine tolerance, 2:56245 (FE-2290-27)
LOW BTU GAS/COST
Low-Btu gas from coal has many potential markets, 2:56966
LOW BTU GAS/PRODUCTION
High- and low-Btu gas from Montana subbituminous coal, 2:55564 (CONF-770814-3)
Report on the successful development of underground coal gasification at Hanna, Wyoming (17 refs), 2:55562 (CONF-770510-8)
LOW LEVEL COUNTERS/LI-DRIFTED GE DETECTORS
Ge(Li) system for the monitoring of low level radioactive gases, 2:57332
LUBRICANTS
See also LUBRICATING OILS
LUBRICANTS/ADDITIVES
Study of chemical behavior of dispersant additives on metal surfaces: reaction of amide functions on aluminum oxide, 2:55774
LUBRICANTS/LOSSES
Investigation of the effect of the design and number of piston rings on lubricant burn-up waste, 2:57057
LUBRICATING OILS
See also WASTE OILS
LUBRICATING OILS/ADDITIVES
Effect of shale-tar additives on the antiwear properties of motor oils, 2:55850
Role of antiwear additives for lube oils in a friction test simulating ring-liner contact, 2:55775
LUBRICATING OILS/PHYSICAL PROPERTIES
Role of antiwear additives for lube oils in a friction test simulating ring-liner contact, 2:55775
LUBRICATING OILS/PRODUCTION
Process for the preparation of low pour point lubricating oils (Patent), 2:55771
LUBRICATING OILS/RECYCLING
Method of rerefining oil with recovery of useful organic additives (Patent), 2:55790
LUBRICATING OILS/TESTING
Role of antiwear additives for lube oils in a friction test simulating ring-liner contact, 2:55775
LUCIE-1 REACTOR/REACTOR INSTRUMENTATION
Preparing for electrical-system startup at a nuclear power plant, 2:56415
LUCIE-1 REACTOR/REACTOR START-UP
Preparing for electrical-system startup at a nuclear power plant, 2:56415
LUNGS/BIOLOGICAL RADIATION EFFECTS
Plutonium in human lung in the Hanford environs, 2:57436 (BNWL-SA-5855)
LUNGS/RADIATION MONITORING
Plutonium in human lung in the Hanford environs, 2:57436 (BNWL-SA-5855)
LURGI PROCESS/ECONOMICS
Success at Westfield, 2:55592
LURGI PROCESS/TECHNOLOGY ASSESSMENT
Success at Westfield, 2:55587
Success at Westfield, 2:55592
LUTETIUM COMPLEXES/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance studies of diamagnetic metal-aminopolycarboxylate complexes, 2:57229

M

MACERALS/REFLECTIVITY
Reflecting power of vitrinites of Polish coals and its correlation with indices of coal class, 2:55646
MACHINE PARTS
See also SHAFTS
SPRINGS
MACHINE PARTS/QUALITY CONTROL
Part stability and fixturing techniques for precision machining, 2:57254 (Y/DA-7177)
MACHINE TOOLS/ACCURACY
Part stability and fixturing techniques for precision machining, 2:57254 (Y/DA-7177)
MAGMA
Evidence for the Azores mantle plume from strontium isotope geochemistry of the Central North Atlantic, 2:57476
MAGMA SYSTEMS/HEAT EXTRACTION
Boiler of tubular nature (Patent), 2:56200
MAGNESIUM/ELECTRONIC STRUCTURE
Electronic structure of the ground and excited states of Mg^+_2 and Mg_2, 2:57502
MAGNESIUM ALLOYS/LATENT HEAT STORAGE
Thermal storage in metals, 2:56160
MAGNESIUM ALLOYS/THERMODYNAMIC PROPERTIES
Thermal storage in metals, 2:56160
MAGNESIUM ALLOYS/WELDABILITY
Ocean transport and storage of liquefied natural gas, 2:55823
MAGNESIUM CHLORIDES/CORROSIVE EFFECTS
Stress-corrosion studies on materials used for surgical implants, 2:57138
MAGNESIUM COMPLEXES/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance studies of diamagnetic metal-aminopolycarboxylate complexes, 2:57229

MAGNESIUM COMPOUNDS/OXIDATION
Oxidation behavior of nickel-chromium-aluminum-yttrium - magnesium oxide and nickel-chromium-aluminum-yttrium - zirconate type of cermets, 2:57163 (N-77-16115)
MAGNESIUM IONS/BIOLOGICAL EFFECTS
Simultaneous influx and efflux of nitrate during uptake by perennial ryegrass, 2:57418
MAGNESIUM IONS/ELECTRONIC STRUCTURE
Electronic structure of the ground and excited states of $Mg^{+}{}_{2}$ and Mg_{2}, 2:57502
MAGNESIUM OXIDES/OXIDATION
Oxidation behavior of nickel-chromium-aluminum-yttrium - magnesium oxide and nickel-chromium-aluminum-yttrium - zirconate type of cermets, 2:57163 (N-77-16115)
MAGNESIUM OXIDES/WETTABILITY
Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R-1746)
MAGNET COILS/FAILURES
Kinetic energy release in missile ejection from confining magnets, 2:57733
MAGNET COILS/STRESSES
Advantages of nonuniform current density distribution in an ohmic heating coil, 2:57736
MAGNETIC BREMSSTRAHLUNG
See SYNCHROTRON RADIATION
MAGNETIC COILS
See MAGNET COILS
MAGNETIC MIRROR TYPE REACTORS/DESIGN
Mechanical design aspects of a Tandem Mirror Fusion Reactor, 2:57712
Reference mirror hybrid fusion-fission reactor design, 2:57713
MAGNETIC MIRROR TYPE REACTORS/MAGNETIC FIELD CONFIGURATIONS
Approaches to small-size field-reversed mirror reactors, 2:57711
MAGNETIC MIRROR TYPE REACTORS/OPTIMIZATION
Parametric design study of Tandem Mirror Fusion Reactors, 2:57707
MAGNETIC MIRROR TYPE REACTORS/PLASMA CONFINEMENT
Parametric investigation of mirror reactor dynamics, 2:57633
MAGNETIC MIRROR TYPE REACTORS/REVIEWS
Magnetic fusion energy (Lectures on status of tokamak and magnetic mirror research), 2:57691 (UCRL-79600)
Review of the mirror hybrid reactor, 2:57690 (UCRL-79548)
MAGNETIC STARS/SPECTRA
CH lines in the spectrum of the magnetic variable 73 Draconis, 2:57481
MAGNETIC STORMS/CHARGED-PARTICLE PRECIPITATION
Analysis of satellite data on energetic particles of ionospheric origin. Final report, 24 Mar. 1975 - 23 Mar. 1976 (0.7 to 12 keV), 2:57491 (N-77-16485)
MAGNETIC STORMS/PROTON PRECIPITATION
Analysis of satellite data on energetic particles of ionospheric origin. Final report, 24 Mar. 1975 - 23 Mar. 1976 (0.7 to 12 keV), 2:57491 (N-77-16485)
MAGNETIC SURVEYS
ERDA's National Aerial Radiometric and Magnetic Survey, 2:57385
MAGNETOACOUSTIC WAVES/EXCITATION
Thermonuclear cyclotron magnetosonic instability of plasma, 2:57673
MAGNETOHYDRODYNAMIC CHANNELS
See MHD CHANNELS
MAGNETOHYDRODYNAMIC GENERATORS
See MHD GENERATORS
MAGNOX TYPE REACTORS/FUEL CYCLE
Nuclear fuel cycle: (4) the reactors, 2:56606
MAIN SEQUENCE STARS/CHEMICAL COMPOSITION
Relative abundances of elements in main-sequence stars, and nucleosynthesis, 2:57479
MAIN SEQUENCE STARS/NUCLEOSYNTHESIS
Relative abundances of elements in main-sequence stars, and nucleosynthesis, 2:57479
MAIN SEQUENCE STARS/STELLAR ATMOSPHERES
Relative abundances of elements in main-sequence stars, and nucleosynthesis, 2:57479
MAN
See also PATIENTS
PERSONNEL
REFERENCE MAN
MAN/BIOLOGICAL RADIATION EFFECTS
Radiation safety (Criteria for radiation protection standards), 2:57428 (CONF-770615-2)
MAN/RADIATION DOSES
Assessment of potential radiation dose-to-man from an acute tritium release into a forest ecosystem, 2:57382 (DP-MS-76-89)
MANGANESE/ENVIRONMENTAL TRANSPORT
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)
MANGANESE ALLOYS/CURIE POINT
Ferromagnetic and antiferromagnetic coupling in amorphous (Ni/sub 100-c/Mn/sub c/)$_{75}P_{14}B_{6}$ (C=0.7 to 20 at.% 1.7 to 270°K), 2:57127 (CALT-822-91)
MANGANESE ALLOYS/MAGNETIZATION
Ferromagnetic and antiferromagnetic coupling in amorphous (Ni/sub 100-c/Mn/sub c/)$_{75}P_{14}B_{6}$ (C=0.7 to 20 at.% 1.7 to 270°K), 2:57127 (CALT-822-91)
MANGANESE ALLOYS/WELDABILITY
Ocean transport and storage of liquefied natural gas, 2:55823
MANPOWER/AVAILABILITY
Energy and natural resources, 2:56930
MARCOULE PHENIX REACTOR
See PHENIX REACTOR
MARINE DISPOSAL/LEGAL ASPECTS
Political and legal implications of radioactive waste disposal at sea, 2:55931
MARINE ECOSYSTEMS
See AQUATIC ECOSYSTEMS
MARINE VEHICLE ACCIDENTS
See ACCIDENTS
MARYLAND/FOSSIL-FUEL POWER PLANTS
Chalk Point Cooling Tower Project. Volume 1. Phase IV, comprehensive field program description. Environmental Systems Corporation's comprehensive project final report, October 1, 1975-June 30, 1976 (Fossil-fuel power plant), 2:57362 (PPSP-CPCTP-12(Vol.1))
Chalk Point Cooling Tower Project. Volume 2. Summer seasonal test data. Environmental Systems Corporation's comprehensive project final report, October 1, 1975-June 30, 1976 (Fossil-fuel power plant), 2:57363 (PPSP-CPCTP-12(Vol.2))
MASS SPECTROMETERS/PERFORMANCE
Analytical capability of the uranium hexafluoride mass spectrometer, 2:57202 (GAT-T-2657)
MATERIAL UNACCOUNTED FOR
Report on strategic special nuclear material inventory differences (Jan. 1, 1968-Sept. 30, 1976), 2:55959 (NUREG-0350(Vol.1)(No.1))
MATERIALS
Biological productivity of renewable resources used as industrial materials, 2:56926 (PB-264457)
Fibers as renewable resources for industrial materials (Review and assessment), 2:56928 (PB-264561)
Reference materials system: a source for renewable materials assessment, 2:56927 (PB-264494)
Ukrainian Physics Journal (Cover-to-cover translation into English of Ukrainskii Fizicheskii Zhurnal, no. 9 (September 1971)), 2:57089 (AEC-tr-7297/9)
MATERIALS/AVAILABILITY
Energy and natural resources, 2:56930
MATERIALS/ENERGY CONSERVATION
Recycling waste (Book), 2:56925
MATERIALS/MECHANICAL PROPERTIES
Implementation of the large mathematical model HEMP on the STAR-100 computers, 2:57822 (UCRL-52277)
MATERIALS/RESEARCH PROGRAMS
Federal look at the needs for energy-related materials research and development. Volume 1. Near-term energy program, 2:57088 (ERDA-76-28V1)
Research in materials science. Final technical report (Materials Research Lab, Univ. of Illinois at Urbana-Champaign), 2:57100 (AD-A-037760)
MATERIALS (FERROELECTRIC)
See FERROELECTRIC MATERIALS
MATERIALS (FERROMAGNETIC)
See FERROMAGNETIC MATERIALS
MATERIALS RECOVERY/FINANCIAL INCENTIVES
Impact of the Federal tax code on resource recovery. Final report (Effect of tax-subsidy elimination), 2:56929 (PB-264886)
MATSUKAWA GEOTHERMAL FIELD/BRINES
Geothermal power plants and their material trends, 2:56202
MATSUKAWA GEOTHERMAL FIELD/GEOTHERMAL FLUIDS
Geothermal power plants and their material trends, 2:56202
MECHANICAL STRUCTURES
See also SUPPORTS
MECHANICAL STRUCTURES/MECHANICAL PROPERTIES
Mechanical behavior of materials and structural elements at elevated temperatures. Progress report, June 1, 1976-May 31, 1977, 2:57110 (COO-2733-11)
MELTDOWN
Meltdown phase for an LMFBR loss of heat sink during shutdown, 2:56828
Role of fission gas in development of the transition phase (LMFBR), 2:56841

Self-consistent normal fluid equation-of-state for (U,Pu)N (LMFBR), 2:56849
MELTDOWN/FLUID FLOW
Flow regime of hydrodynamically unstable melting systems, 2:56836
MELTDOWN/HEAT TRANSFER
Heat transfer from a pool of molten UO_2 to a concrete slab, 2:56835
Natural-convective cooling of a bed of fuel debris, 2:56834
MELTDOWN/MOLTEN METAL-WATER REACTIONS
Experiences with vapor explosions caused by entrapment of water with melts, 2:56868
MELTDOWN/POOL BOILING
Limits of stability of internally heated boiling pools (LMFBR), 2:56842
Role of condensation on dispersion of closed boiling UO_2 systems (LMFBR), 2:56843
MELTDOWN/PROBABILITY
Some probabilistic aspects of the seismic risk of nuclear reactors, 2:56789 (PB-265020)
MELTDOWN/SIMULATION
Material compatibility studies for PAHR incore molten pool experiments, 2:56838
MELTING POINTS/ISOTOPE EFFECTS
Condensed phase isotope effects, especially vapor pressure isotope effects: aqueous solutions, 2:57234
MERCURY/ABSORPTION SPECTROSCOPY
Mercury titration in natural gas by flameless atomic absorption, 2:55827
MERCURY/BIOCHEMICAL REACTION KINETICS
Influence of Hg^{2+} on the excited states of DNA: photochemical consequences, 2:57408 (CONF-770346-1)
MERCURY/GEOCHEMISTRY
Mercury in underground waters of the West Siberian oil and gas bearing basin, 2:57477
MERCURY PLANET/INFRARED RADIATION
Infrared upconverter for astronomical imaging, 2:57341
METAL INDUSTRY
See also MINERAL INDUSTRY
METAL INDUSTRY/ENERGY CONSERVATION
Electric conductive billet heaters, 2:57034
Heating bell furnaces with natural gas, 2:57041
Thermal operation of double-bath steel-smelting furnaces, 2:57042
METAL INDUSTRY/HEALTH HAZARDS
Evaluation of the hazard associated with fabricating beryllium copper alloys, 2:57461 (UCRL-52258)
METAL INDUSTRY/HEATERS
Electric conductive billet heaters, 2:57034
METAL INDUSTRY/RECYCLING
Impact of the Federal tax code on resource recovery. Final report (Effect of tax-subsidy elimination), 2:56929 (PB-264886)
METAL INDUSTRY/WASTE HEAT UTILIZATION
Considerate steelmaking helps cut steel costs, 2:57046
METALS
See also ACTINIDES
ALKALI METALS
LIQUID METALS
METALS/ELECTRIC CONDUCTIVITY
Relationship between defect resistivity and bulk resistivity at the melting temperature, 2:57130
METALS/ENVIRONMENTAL TRANSPORT
National trends in trace metals in ambient air, 1965-1974, 2:57354 (EPA-450/1-77-003)
METALS/ION IMPLANTATION
Ion implantation in metals, 2:57095 (SAND-77-0373)
METALS/MATERIALS RECOVERY
Thermodynamic estimation of the minimum concentration attainable in a flow-through porous electrode reactor, 2:57048
METALS/MECHANICAL PROPERTIES
Mechanical behavior of materials and structural elements at elevated temperatures. Progress report, June 1, 1976-May 31, 1977, 2:57110 (COO-2733-11)
Science of materials. Progress report, July 1, 1976-June 30, 1977, 2:57102 (COO-1198-1181)
METALS/PHYSICAL RADIATION EFFECTS
Effect of implanted interstitials on swelling during self-ion bombardment, 2:57145
Systematic approach to the radiation damage problem in fission and fusion reactor structural alloys, 2:57143 (UWFDM-184)
METALS/TOXICITY
Trace metal toxicity in aquatic teleosts (fishes), 2:57454
METAMORPHIC ROCKS
See also SANDSTONES
METAMORPHIC ROCKS/GEOTHERMOMETRY
Temperature and pressure of the Ryoke gneisses estimated by garnet-cordierite geothermometer, 2:56214
METAMORPHIC ROCKS/PETROLOGY
General study of the region of Lake Titicaca, Bolivia, using a satellite multispectral scanning system. Petrologic study of metamorphic rocks in the Zongo Valley in Bolivia. Installation project of a bacteria in the Los Monos Plains. Geological study of the Ulla Charzani region, 2:57463 (E-76-10453)
METHANATION/FLUIDIZED BED
Gas generator research and development: BI-GAS process. Quarterly report, January-March 1977, 2:55567 (FE-1207-29)
METHANE/BIOSYNTHESIS
Don't waste waterweeds (Use of water hyacinths as fertilizer, biogas generator, and animal feed), 2:55994
METHANE/CHEMICAL REACTION YIELD
Methane formation in tritium gas exposed to stainless steel, 2:55968 (UCRL-52262)
METHANE/ELECTRON-MOLECULE COLLISIONS
(e,2e) reaction, 2:57550
METHANE/ENERGY LEVELS
(e,2e) reaction, 2:57550
METHANE/RECOVERY
Analysis of electricity production costs from the geopressured geothermal resource, 2:56194 (BNWL-2192)
METHANE/SYNTHESIS
Process for the methanation of gases containing high concentration of carbon monoxide (Patent; methanation of water gas from coal gasification), 2:55987
METHANOL/SYNTHESIS
Molding of a low-temperature catalyst for methanol synthesis, 2:55995
METHOXYBENZENE
See ANISOLE
METHYLACETYLENE
See PROPYNE
METHYLBENZENE
See TOLUENE
MHD CHANNELS/HALL EFFECT
High magnetic field MHD generator program. Quarterly report, October-December 1976, 2:56996 (FE-2341-1)
MHD CHANNELS/PLASMA INSTABILITY
High magnetic field MHD generator program. Quarterly report, October-December 1976, 2:56996 (FE-2341-1)
MHD CHANNELS/SLAGS
Velocity and temperature distributions of coal-slag layers on magnetohydrodynamic generator walls, 2:56997 (N-77-16445)
MHD GENERATORS
See also CLOSED-CYCLE MHD GENERATORS
COAL-FIRED MHD GENERATORS
LIQUID-METAL MHD GENERATORS
MHD GENERATORS/COMBUSTION CHAMBERS
Experimental investigation of vibration regimes of combustion in combustion chambers of the U-25 plant, 2:56994
MHD GENERATORS/COMBUSTION PRODUCTS
Measurement of excess oxidizer ratio in MHD generator combustion products, 2:56993
MHD GENERATORS/FLUID FLOW
High magnetic field MHD generator program. Quarterly report, October-December 1976, 2:56996 (FE-2341-1)
MHD GENERATORS/FUEL-AIR RATIO
Measurement of excess oxidizer ratio in MHD generator combustion products, 2:56993
MHD GENERATORS/PILOT PLANTS
Some results of investigations with the U-25 pilot plant to bring it up to design parameters, 2:56990
MHD GENERATORS/SUPERCONDUCTING MAGNETS
Applications of superconducting magnets to energy with particular emphasis on fusion power, 2:57740
MICELLAR-POLYMER FLOODING
See MICROEMULSION FLOODING
MICROBIAL FLORA
See MICROORGANISMS
MICROELECTRONIC CIRCUITS/PERFORMANCE TESTING
Monitoring sinusoidal vibration environments with a television system, 2:57314 (BDX-613-1295(Rev.))
MICROEMULSION FLOODING/MATHEMATICAL MODELS
Performance of the Taber South polymer flood, 2:55763
MICROFLORA
See MICROORGANISMS
MICROORGANISMS
See also BACTERIA
VIRUSES
MICROORGANISMS/BIOMASS
Adenosine triphosphate concentration in relation to microbial biomass in aquatic systems, 2:57389 (COO-1599-120)
MICROORGANISMS/CHEMICAL ANALYSIS
Adenosine triphosphate concentration in relation to microbial biomass in aquatic systems, 2:57389 (COO-1599-120)
MICROPROCESSORS/PROGRAMMING
Specialization of SARA for software synthesis, 2:57819 (UCLA-34P214-37)
MICROPROCESSORS/PROGRAMMING LANGUAGES
User's guide to the LLL BASIC interpreter (For 8080-based MCS-80 microcomputer system), 2:57816 (UCID-17090(Rev.1))

MICROWAVE POWER TRANSMISSION/FEASIBILITY STUDIES
Astronautical energy solution, 2:56082
MID-ATLANTIC RIDGE/GEOCHEMICAL SURVEYS
Evidence for the Azores mantle plume from strontium isotope geochemistry of the Central North Atlantic, 2:57476
MIDDLE EAST/OIL FIELDS
Rolls-Royce Avon in the Middle East, 2:55764
MILKY WAY/ENERGY LOSSES
Extinction towards the South Galactic Pole determined from reddening of A and F stars, 2:57486
MILL TAILINGS/RADIATION MONITORING
Measurements of surface radon fluxes from uranium mill tailings, 2:55940
MINERAL INDUSTRY
See also CHEMICAL INDUSTRY
COAL INDUSTRY
METAL INDUSTRY
OIL SHALE INDUSTRY
PETROLEUM INDUSTRY
MINERAL INDUSTRY/ECONOMICS
Mineral industry in the Canadian economy: review and outlook, 2:56920
MINERAL INDUSTRY/PRODUCTIVITY
Mineral industry in the Canadian economy: review and outlook, 2:56920
MINERAL INDUSTRY/REGIONAL ANALYSIS
Regional mineral developments, 2:56931
MINERAL INDUSTRY/TRADE
Canadian non-fuel minerals in the international scene and foreign policy, 2:56932
MINERAL OIL
See LUBRICANTS
MINERAL RESOURCES/EXPLOITATION
State taxation of mineral deposits and production. Final report (Western states), 2:56956 (PB-264575)
MINERAL RESOURCES/TAXES
State taxation of mineral deposits and production. Final report (Western states), 2:56956 (PB-264575)
MINERALS
See also ARAGONITE
MINERALS/PHYSICAL PROPERTIES
Equipment for investigation of physical properties of rocks and minerals at different high pressure intervals, 2:56212
MINES
See also COAL MINES
URANIUM MINES
MINES/SOLAR SPACE HEATING
Regional conditions and the possibility of application of low temperature solar heaters in Yakutian mines, 2:56102
MINING
See also COAL MINING
SURFACE MINING
UNDERGROUND MINING
MINING/WATER POLLUTION
Water pollution caused by inactive ore and mineral mines - a national assessment. Final report, 2:57393 (PB-264 936)
MINING EQUIPMENT
See also CONVEYORS
CUTTER LOADERS
Feed system of a coal getting combine (Patent; 11 claims), 2:55670
MINING EQUIPMENT/AUTOMATION
Foreseeable developments of mining techniques in large coal-producing countries, 2:55687
MINING EQUIPMENT/DESIGN
Fabricate and evaluate protective canopies for 3-foot coal seams. Final report, 1975-1976, 2:55673 (PB-265073)
MINING EQUIPMENT/PERFORMANCE
Ranging-arm shearer: its introduction in the Barnsley seam at Frickley Colliery, 2:55686
MINING EQUIPMENT/PERFORMANCE TESTING
Fabricate and evaluate protective canopies for 3-foot coal seams. Final report, 1975-1976, 2:55673 (PB-265073)
MINING EQUIPMENT/RELIABILITY
Foreseeable developments of mining techniques in large coal-producing countries, 2:55687
MINING EQUIPMENT/REVIEWS
Mining engineering's annual review of coal and industrial minerals. I, 2:55684
MINNESOTA/GEOLOGICAL SURVEYS
Crustal structure and seismicity in Minnesota, 2:57472
MINNESOTA/SEISMIC SURVEYS
Crustal structure and seismicity in Minnesota, 2:57472
MIRRORS/MACHINING
Part stability and fixturing techniques for precision machining, 2:57254 (Y/DA-7177)
MIRRORS/REFLECTIVITY
Reflection coefficient for a back-surface glass mirror, 2:56148
Specular reflectance properties of mirror materials, 2:56149
MISSILES/ELECTRONIC GUIDANCE
Fusible heat sink for a cryogenic refrigerator, 2:57265 (AD-D-003515)
MIXED OXIDE FUEL FABRICATION PLANTS/RISK ASSESSMENT
Preliminary accident radiological risk assessment of a large commercial MOX fuel fabrication plant, 2:55945
MIXTURES/PARTICLE SIZE
Fundamental statistical methods in particle science, 2:57181 (LA-UR-77-1098)
MOBIL M-GASOLINE PROCESS
See also GASOLINE
SYNTHETIC FUELS
MOBIL M-GASOLINE PROCESS/FLUIDIZED BED
Fluid bed process studies on selective conversion of methanol to high octane gasoline. Monthly report for May 1977, 2:55983 (FE-2490-8)
MOBIL M-GASOLINE PROCESS/PILOT PLANTS
Fluid bed process studies on selective conversion of methanol to high octane gasoline. Monthly report for May 1977, 2:55983 (FE-2490-8)
MOBILE HOMES/SAFETY STANDARDS
Proposed safety standards for ERDA trailers and other portable structures, 2:57313 (UCID-17456)
MODELS (COSMOLOGICAL)
See COSMOLOGICAL MODELS
MODIFIED IN-SITU PROCESSES
Modified in-situ oil shale technology at the Lawrence Livermore Laboratory: experimental results and present status, 2:55837 (UCRL-79149)
MOLECULAR ORBITAL MODEL
See MOLECULES
MOLECULAR SIEVES/PERFORMANCE
Cryosorption pumping of helium at 4.2 K by Type 5A molecular sieve, 2:57797
MOLECULE COLLISIONS
See also ION-MOLECULE COLLISIONS
MOLECULE-MOLECULE COLLISIONS
PHOTON-MOLECULE COLLISIONS
MOLECULE COLLISIONS/REVIEWS
Progress in the quantum dynamics of reactive molecular collisions (Three-dimensional calculations, resonances, nonadiabatic chemical reactions), 2:57531
MOLECULE-MOLECULE COLLISIONS/RELAXATION
Non-adiabatic effects in collisional vibrational relaxation of diatomic molecules (Semiclassical approximation, review), 2:57532
MOLECULE-MOLECULE COLLISIONS/VIBRATIONAL STATES
Non-adiabatic effects in collisional vibrational relaxation of diatomic molecules (Semiclassical approximation, review), 2:57532
MOLECULES/BINDING ENERGY
Classification of Feshbach resonances in electron-molecule scattering, 2:57530
MOLECULES/ENERGY LEVELS
Classification of Feshbach resonances in electron-molecule scattering, 2:57530
Production and detection of highly excited states, 2:57508
MOLECULES/EXCITATION
Quantum versus classical dynamics in the treatment of multiple photon excitation of the anharmonic oscillator, 2:57552
MOLECULES/INFORMATION SYSTEMS
Time for atomic and molecular data bases is now (an overview of data management research at LLL), 2:57832 (UCRL-79286)
MOLECULES/X-RAY SPECTRA
Quasimolecular K x-rays (Review), 2:57505
MOLLUSCS
Effect of salinity on cadmium uptake by the tissues of the shore crab Carcinus maenas, 2:57451
MOLLUSCS/CONTAMINATION
Effect of calcium on cadmium uptake by the shore crab Carcinus maenas, 2:57449
Effects of environmental factors on radiocadmium uptake by four species of marine bivalves, 2:57447
MOLLUSCS/ECOLOGICAL CONCENTRATION
Fate of nuclides in natural water systems. Annual progress report, October 1, 1976-September 30, 1977 (Natural ^{234}Th and ^{210}Po tracer studies of trace metal cycling in coastal waters), 2:57353 (COO-3573-26)
MOLTEN METAL-WATER REACTIONS
Experiences with vapor explosions caused by entrapment of water with melts, 2:56868
MOLTEN METAL-WATER REACTIONS/TEST FACILITIES
Large scale sodium-water reaction tests for Monju steam generators, 2:56509 (CONF-760503-P1)

MOLTEN SALT REACTORS/STEAM GENERATORS
Low temperature steam generator (Patent; Molten Salt Reactor), 2:56459
MOLTEN SALTS/LATENT HEAT STORAGE
Demand sensitive energy storage in molten salts, 2:56157
MOLYBDENUM/COMPATIBILITY
Compatibility of bismuth and bismuth-lithium solutions with refractory metals and graphite, 2:57108 (CONF-760503-P2)
MOLYBDENUM/CORROSION
Corrosion of iron-base alloys by lithium, 2:57134 (CONF-760503-P2)
MOLYBDENUM/PHYSICAL RADIATION EFFECTS
Damage profile in molybdenum bombarded with Ni^{++} and (Ni^{++} + He^{+}) ions, 2:57146
Depth distribution of damage in ion-bombarded molybdenum (5-MeV Ni^{++}), 2:57147
MOLYBDENUM ORES/RESERVES
Canadian reserves of seven metals, 2:56933
MONEL/EXPLOSION WELDING
Properties of explosive-welded Monel-clad steels, 2:56680
MONITORS (FAILED ELEMENTS)
See FAILED ELEMENT MONITORS
MONITORS (REACTOR)
See REACTOR CONTROL SYSTEMS
MONJU REACTOR/REACTOR VESSELS
Thermal distortion of mock-up reactor vessel of fast breeder reactor, 2:56556
MONJU REACTOR/STEAM GENERATORS
Large scale sodium-water reaction tests for Monju steam generators, 2:56509 (CONF-760503-P1)
MONOCRYSTALS/SURFACE FINISHING
Simple goniometer for precise grinding and electropolishing of single crystal surfaces, 2:57343
MONTANA/COAL LIQUEFACTION
Coal liquefaction: technology, impacts, and technical suitability for Montana (Extensive bibliography), 2:55614 (NP-22092)
MONTANA/COAL MINING
Coal development information packet. Supplement 1, 2:55655 (NP-22076)
MOON/INFRARED RADIATION
Infrared upconverter for astronomical imaging, 2:57341
MUF
See MATERIAL UNACCOUNTED FOR
MULTI-CHANNEL ANALYZERS/CALIBRATION
10-channel neutral particle energy analyser for measurements of ion temperatures on tokamak plasmas, 2:57642
MUNICIPAL WASTES/HEAT RECOVERY
European waste-to-energy systems. An overview, 2:57022 (CONS/2103-6)
MUNICIPAL WASTES/PYROLYSIS
Pyrolysis process for converting refuse to fuel gas (Patent; optimization of Purox Pyrolysis Process), 2:55993
MUNICIPAL WASTES/RECYCLING
Recycling waste (Book), 2:56925
MUNICIPAL WASTES/USES
European waste-to-energy systems: case study of Koersor, Denmark, 2:56980 (CONS/2103-3)
European waste-to-energy systems. Case study of Munich: Munich North IA and IB, Munich North II, Munich South IV and V, 2:56981 (CONS/2103-4)
European waste-to-energy systems: case study of Geneva-Cheneviers (Switzerland), 2:56987 (CONS/2103-2)
Incineration of domestic refuse: experience in Germany, 2:56247
Incineration of domestic refuse: refuse into energy at Sheffield, 2:56248
Incineration of domestic refuse: power from refuse at Kynoch works, 2:56249
MUNICIPAL WASTES/WASTE DISPOSAL
Solid waste disposal feasibility study for Richmond County, Georgia Board of Commissioners, 2:57316 (PB-264471)
MUNICIPAL WASTES/WASTE PROCESSING
Incineration of domestic refuse: power from refuse at Kynoch works, 2:56249
MUON REACTIONS
Inelastic interaction of muons with Fe nuclei at small Q^2 in the energy region above 200 GeV, 2:57596
MUSSELS
See MOLLUSCS

N

N*RESONANCES/PARTICLE PRODUCTION
Polarization phenomena in isobar production by a weak neutral current, 2:57577
NATIONAL ACCELERATOR LABORATORY
See FERMILAB ACCELERATOR
NATO
(North Atlantic Treaty Organization.)
Petropolitics and the Atlantic Alliance (Short- and long-term effects of petroleum crisis), 2:56969 (AD-A-037807)
NATURAL DRAFT COOLING TOWERS/ENVIRONMENTAL EFFECTS
Chalk Point Cooling Tower Project. Volume 1. Phase IV, comprehensive field program description. Environmental Systems Corporation's comprehensive project final report, October 1, 1975-June 30, 1976 (Fossil-fuel power plant), 2:57362 (PPSP-CPCTP-12(Vol.1))
NATURAL GAS
See also LIQUEFIED NATURAL GAS
NATURAL GAS/BY-PRODUCTS
Natural gas: feedstock for ethylene plants, 2:55808
Small ammonia plants: prospects for natural-gas utilization in developing countries, 2:55810
NATURAL GAS/CHEMICAL ANALYSIS
Mercury titration in natural gas by flameless atomic absorption, 2:55827
NATURAL GAS/COMBUSTION
Control of the level of NO/sub x/ in the indoor environment, 2:57459 (CONF-770557-2)
Measurement of excess oxidizer ratio in MHD generator combustion products, 2:56993
NATURAL GAS/COMBUSTION PRODUCTS
Heating bell furnaces with natural gas, 2:57041
NATURAL GAS/ECONOMIC ELASTICITY
Project Independence evaluation system (PIES) documentation. Volume VI. Methodology for improving the price sensitivity of the PIES oil and gas supply curves, 2:56950 (PB-264069)
NATURAL GAS/ELECTRIC HEATING
Direct electric gas heating for gas turbines, 2:56279
NATURAL GAS/ENERGY CONSERVATION
Some aspects of natural gas conservation, 2:57031
NATURAL GAS/PIPELINES
Support grows for trans-Australia gas pipeline, 2:56974
NATURAL GAS/PROCESSING
Natural gas: feedstock for ethylene plants, 2:55808
NATURAL GAS/PRODUCTION
Project Independence evaluation system (PIES) documentation. Volume VII. Methodology for developing more complex investment and production profiles in the FEA oil and gas supply model, 2:56951 (PB-264649)
NATURAL GAS/PURIFICATION
Catalytical removal of nitrogen oxide exemplified by a large plant, 2:55809
NATURAL GAS/REFRIGERATION
Natural-gas liquefaction by an expansion-turbine mixture cycle, 2:55813
NATURAL GAS/STORAGE
Peak-shaving with Groningen natural gas, 2:55812
NATURAL GAS/TRANSPORT
Cathodic protection of pipes and pipelines offshore, 2:55797
Some problems of hydraulic calculation of gas pipelines transporting gas and air mixture, 2:55824
NATURAL GAS/UNDERGROUND STORAGE
Requirements for salt cavity stability analysis, 2:55828
NATURAL GAS APPLIANCES
See GAS APPLIANCES
NATURAL GAS DEPOSITS/CLASSIFICATION
Classification of hydrocarbon pools, 2:55802
NATURAL GAS DEPOSITS/DISTRIBUTION
Oil and gas geological zoning of the Siberian Platform, 2:55741
NATURAL GAS DEPOSITS/EVALUATION
Evaluation of oil and gas potential in Maykopian sedimentary rocks in crimeia, west pre-caucausus and offshore areas of Karkinit Bay and Azov Sea, 2:55754
NATURAL GAS DEPOSITS/EXPLORATION
Calculation of oil and solution and free gas initially in place and their recovery during exploration, 2:55749
Data base for analyzing results of oil and gas exploration, 2:55748
Directions and tasks of oil exploration in the southern part of Timan-Pechora province for 1976-1980, 2:55807
Formation of oil and gas pools and technique for their exploration in southern regions of Siberian platform, 2:55753
Geothermal conditions of subsalt rocks of the eastern part of pre-caspian depression and their oil and gas potential, 2:55751
Paleozoic carbonate formations in the south-east of Russian Platform and their oil and gas potential, 2:55752
NATURAL GAS DEPOSITS/GEOLOGY
Data base for analyzing results of oil and gas exploration, 2:55748
NATURAL GAS DEPOSITS/GEOPHYSICAL SURVEYS
Direction of exploration and possibilities of hydrocarbon pool discoveries in the Volyno-Podolian area, 2:55747

NATURAL GAS DEPOSITS/PETROGENESIS
Cyclic character of the processes of oil and gas generation, petroliferous provinces, basins and regions, 2:55742
NATURAL GAS DEPOSITS/SPATIAL DISTRIBUTION
Cyclic character of the processes of oil and gas generation, petroliferous provinces, basins and regions, 2:55742
NATURAL GAS DISTRIBUTION SYSTEMS
See also PIPELINES
NATURAL GAS DISTRIBUTION SYSTEMS/CONSTRUCTION
Pipeline system for more natural gas from the North Sea, 2:55820
NATURAL GAS DISTRIBUTION SYSTEMS/OFFSHORE OPERATIONS
Pipeline system for more natural gas from the North Sea, 2:55820
NATURAL GAS DISTRIBUTION SYSTEMS/SIMULATION
Calculation of nonstationary gas network using the Ganesi program system, 2:55821
Nonstationary gas network calculation: simulation and comparative measurement, 2:55822
NATURAL GAS DISTRIBUTION SYSTEMS/VALVES
Add-on sectionalizing valves for medium-pressure systems, 2:55817 (CONF-770577-1)
NATURAL GAS FIELDS/OFFSHORE OPERATIONS
DEROCS: a computer program to simulate offshore oil and natural gas development scenarios and onshore service base requirements, 2:55757 (USGS-OFR-77-130)
NATURAL GAS FIELDS/SEISMIC EFFECTS
Seismicity and faulting attributable to fluid extraction, 2:55794
NATURAL GAS FIELDS/SPATIAL DISTRIBUTION
Predicting oil and gas potential from tectonic conditions of distribution of oil and gas fields in west Pre-caucasus, 2:55743
NATURAL GAS GATHERING SYSTEMS
See NATURAL GAS DISTRIBUTION SYSTEMS
NATURAL GAS INDUSTRY/COMMUNICATIONS
Modern mobile radio system, 2:55826
NATURAL GAS INDUSTRY/MANAGEMENT
Business systems for hydrocarbon resources: their credibility in retrospect and in prospect, 2:55816
Metricating the crude oil and natural gas industry, 2:55703
NATURAL GAS PROCESSING PLANTS/PIPES
Targeting in pipe networks of gas plants, 2:55811
NATURAL GAS WELLS/ELECTRIC HEATING
Electrofrac's secondary oil recovery systems, 2:55756 (NP-22197)
NATURAL GAS WELLS/GAS INJECTION
Rock-fluid relationship studies on the Windfall D-3A reservoir and their application in evaluatiang gas cycling effectiveness, 2:55744
NATURAL GAS WELLS/WELL CASINGS
Study to improve downhole equipment for high-pressure gas wells, 2:55806
NATURAL GAS WELLS/WELL COMPLETION
Study to improve downhole equipment for high-pressure gas wells, 2:55806
NATURAL GAS WELLS/WELL STIMULATION
Recovery of retrograde condensed liquids by revaporization during dry gas injection, 2:55815
NATURAL RADIOACTIVITY
(For unspecified naturally occuring radioisotopes only; not for BACKGROUND RADIATION.)
NATURAL RADIOACTIVITY/MONITORING
External environmental radiation levels from natural sources, 2:57369
NEBRASKA/GEOLOGICAL SURVEYS
Seismicity and tectonic relationships of the Nemaha Uplift in Oklahoma, Kansas, and Nebraska, 2:57473
NEGATIVE IONS
See ANIONS
NEOPLASMS
See also LEUKEMIA
NEOPLASMS/BIOCHEMISTRY
Studies in developmental immunogenetics. Annual progress report, 2:57406 (CALT-767P6-X12)
NEOPLASMS/RADIOINDUCTION
Radiation carcinogenesis. Progress report IV, 15 March 1976-15 May 1977 (Abscopal effects of radiation on parabiant rats), 2:57435 (COO-3017-31)
NEP-1 REACTOR/REACTOR SAFETY
Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I-VI, 2:56787 (ORNL/NUREG/NSIC-136)
NEP-2 REACTOR/REACTOR SAFETY
Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I-VI, 2:56787 (ORNL/NUREG/NSIC-136)
NEUTRAL ATOM BEAM INJECTION/SLOWING-DOWN
Application of a unified slowing-down theory to fusion plasmas, 2:57648
NEUTRINO-NEUTRON INTERACTIONS/INCLUSIVE INTERACTIONS
Inclusive γp and γn charged-current neutrino reactions below 6 GeV, 2:57564
NEUTRINO-PROTON INTERACTIONS/INCLUSIVE INTERACTIONS
Inclusive γp and γn charged-current neutrino reactions below 6 GeV, 2:57564
NEUTRON ABSORBERS
See also BURNABLE POISONS
NEUTRON ABSORBERS/PHYSICAL PROPERTIES
Control material behavior in commercial reactors, 2:56722
NEUTRON ABSORBERS/REACTIVITY WORTHS
Absorber materials for fast reactor control applications, 2:56723
NEUTRON DETECTORS
See also FISSION FOIL DETECTORS
Neutron-flux instrumentation for a boiling water reactor, 2:56391
NEUTRON DETECTORS/DESIGN
Apparatus for measuring neutron flux distribution in a reactor (Patent), 2:56698
NEUTRON DOSIMETRY
Neutron dosimetry at the intense neutron source (INS), 2:57788 (LA-UR-77-1033)
NEUTRON FLUX/TWO-DIMENSIONAL CALCULATIONS
Neutron flux calculations with regard to radiation damage, explained for the geometry of a KWU 1300-MWe PWR facility, 2:56416
NEUTRON MONITORS/PERFORMANCE
Measurement of Nb 93m activity determining the fluence of fast neutrons in power reactors, 2:56665
NEUTRON MULTIPLIER FACILITY
See SUBCRITICAL ASSEMBLIES
NEUTRON RADIOGRAPHY
Conversion efficiency enhancement in neutron radiography, 2:57310
Modulation transfer functions for high-speed-motion neutron radiography systems, 2:57312
Neutron radiography at the FR 2 in operation, 2:56763
NEUTRON REACTIONS/CAPTURE
Neutron capture cross section of ^{240}Pu (200 eV to 350 keV), 2:57603
NEUTRON REACTIONS/ELASTIC SCATTERING
Differential cross section of ^{238}U at 144 keV, 2:57602
NEUTRON REACTIONS/FAST FISSION
Cross section for fission of ^{244}Pu by fast neutrons, 2:57608
Fission cross section of ^{249}Bk between 0.7 and 3.0 MeV, 2:57607
X rays from fragments in fission of ^{235}U by 3.5-MeV neutrons, 2:57609
NEUTRON REACTIONS/FISSION
Measurement of the fission cross section of ^{241}Pu from 8 eV to 70 keV, 2:57605
Measurement of the ^{238}U subthreshold fission cross section for incident neutron energies between 0.6 and 100 keV, 2:57606
NEUTRON REACTIONS/INELASTIC SCATTERING
Differential cross section of ^{238}U at 144 keV, 2:57602
NEUTRON REACTIONS/TOTAL CROSS SECTIONS
Comments on the energy-averaged total neutron cross sections of structural materials in the few MeV range, 2:57591 (ANL/NDM-33)
NEUTRON REFLECTORS/STRESSES
Graphite reflector in HTR with pebble bed and OTTO-fueling, 2:56445
NEUTRON SOURCES
(Excludes reactors even when used as neutron sources.)
NEUTRON SOURCES/EXPLOSIONS
Neutron and energetic ion production in exploded polyethylene fibers, 2:57652
NEUTRON SOURCES/FABRICATION
Electron beam welding using fusion and cold wire fill, 2:57090 (GEPP-297)
NEUTRON SOURCES/NEUTRON DOSIMETRY
Neutron dosimetry at the intense neutron source (INS), 2:57788 (LA-UR-77-1033)
NEUTRON SOURCES/SPECIFICATIONS
Production of 14 MeV neutrons by heavy ions (Patent), 2:57802
NEUTRON SPECTROMETERS/ON-LINE CONTROL SYSTEMS
Users guide to finger, thumb, and triple axis real time experiment control programs, 2:57335 (IS-4169)
NEUTRON-RICH ISOTOPES/NEUTRON DENSITY
Self-consistent calculation of the neutron and proton densities of nuclei, 2:57613
NEUTRON-RICH ISOTOPES/PROTON DENSITY
Self-consistent calculation of the neutron and proton densities of nuclei, 2:57613
NEUTRONS
See also FAST NEUTRONS
NEUTRONS/DECAY
Discrete neutron decay constants above the Corngold limit for infinite slabs, 2:56645

NEUTROPHILS/BIOCHEMISTRY
Mechanisms of innate immunity: cytoplasmic granules of polymorphonuclear neutrophilic granulocytes, antimicrobial action, translocation, role, and fate in antimicrobial phagocytosis. Progress report, March 1976-June 30, 1977, 2:57413 (ORO-3628-11)
NEUTROPHILS/IMMUNITY
Mechanisms of innate immunity: cytoplasmic granules of polymorphonuclear neutrophilic granulocytes, antimicrobial action, translocation, role, and fate in antimicrobial phagocytosis. Progress report, March 1976-June 30, 1977, 2:57413 (ORO-3628-11)
NEVADA TEST SITE/HYDROLOGY
Constitutive relations for flow of water in the unsaturated zone (Nevada test site), 2:57383 (NVO-1253-11)
NEVADA TEST SITE/RADIATION MONITORING
Ratio estimation techniques in the analysis of environmental radionuclide data, 2:57379 (BNWL-SA-5975(Rev.))
NEVADA TEST SITE/RADIONUCLIDE MIGRATION
Constitutive relations for flow of water in the unsaturated zone (Nevada test site), 2:57383 (NVO-1253-11)
NEW ENGLAND POWER CO. NUCLEAR PROJECT-1
See NEP-1 REACTOR
NEW ENGLAND POWER CO. NUCLEAR PROJECT-2
See NEP-2 REACTOR
NEW MEXICO/COAL DEPOSITS
Guidebook to coal geology of northwest New Mexico. Circular 154, 2:55659 (NP-22279)
NEW MEXICO/GEOLOGY
Geology and hydrology in the vicinity of the inactive uranium mill tailings pile, Ambrosia Lake, New Mexico, 2:55935 (LA-6839-MS)
NEW MEXICO/GEOPHYSICAL SURVEYS
Subsurface temperature data in Jemez Mountains, New Mexico. Circular 151, 2:56182 (NP-22280)
NEW MEXICO/HEAT FLOW
Terrestrial heat flow along the Rio Grande rift, New Mexico and southern Colorado, 2:56177 (PB-265038)
NEW MEXICO/HYDROLOGY
Geology and hydrology in the vicinity of the inactive uranium mill tailings pile, Ambrosia Lake, New Mexico, 2:55935 (LA-6839-MS)
NEW YORK/ENERGY DEMAND
Land use-energy simulation model: a computer-based model for exploring land use and energy relationships, 2:56915 (BNL-50634)
NEW ZEALAND/ENERGY POLICY
Energy scenarios for New Zealand. Report No. 19, 2:56955 (NP-22250)
NEWBOLD ISLAND-1 REACTOR
See HOPE CREEK-1 REACTOR
NEWBOLD ISLAND-2 REACTOR
See HOPE CREEK-2 REACTOR
NICKEL/ABSORPTIVITY
Optical properties of selectively absorbing Ni/Al_2O_3 composite films, 2:57168
NICKEL/CATALYTIC EFFECTS
Mechanism of the decomposition of ammonia on nickel films at temperatures below and above the Curie point, 2:55997
Surface structure and mechanisms of gasification catalyst deactivation. Annual report, February 1976-January 1977 (Ni coprecipitated catalysts), 2:55574 (FE-2229-4)
NICKEL/ECOLOGICAL CONCENTRATION
Fate of nuclides in natural water systems. Annual progress report, October 1, 1976-September 30, 1977 (Natural ^{234}Th and ^{210}Po tracer studies of trace metal cycling in coastal waters), 2:57353 (COO-3573-26)
NICKEL/PHYSICAL RADIATION EFFECTS
Effect of implanted interstitials on swelling during self-ion bombardment, 2:57145
NICKEL/X-RAY FLUORESCENCE ANALYSIS
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57198 (LA-6869-MS)
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57197 (LA-6869)
NICKEL ALLOYS
See also CHROMIUM-NICKEL STEELS
NICKEL BASE ALLOYS
NICKEL STEELS
NICKEL ALLOYS/AGING
Characterization and aging kinetics study of gamma prime strengthened Fe-Cr-Ni experimental alloys for breeder reactors, 2:57119 (WARD-AD-3045-5)
NICKEL ALLOYS/CURIE POINT
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
NICKEL ALLOYS/ELECTRIC CONDUCTIVITY
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
NICKEL ALLOYS/MAGNETIC MOMENTS
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
NICKEL ALLOYS/OXIDATION
Oxidation behavior of nickel-chromium-aluminum-yttrium - magnesium oxide and nickel-chromium-aluminum-yttrium - zirconate type of cermets, 2:57163 (N-77-16115)
NICKEL BASE ALLOYS
See also COLMONOY
INCONEL 671
MONEL
NICKEL BASE ALLOYS/CURIE POINT
Ferromagnetic and antiferromagnetic coupling in amorphous (Ni/sub 100-c/Mn/sub c/)$_{75}P_{14}B_6$ (C=0.7 to 20 at.% 1.7 to 270°K), 2:57127 (CALT-822-91)
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
NICKEL BASE ALLOYS/ELECTRIC CONDUCTIVITY
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
NICKEL BASE ALLOYS/FRICTION
Evaluation of cobalt and nickel base materials for sliding and static contact applications in a liquid metal fast breeder reactor, 2:56498 (CONF-760503-P1)
NICKEL BASE ALLOYS/MAGNETIC MOMENTS
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
NICKEL BASE ALLOYS/MAGNETIZATION
Ferromagnetic and antiferromagnetic coupling in amorphous (Ni/sub 100-c/Mn/sub c/)$_{75}P_{14}B_6$ (C=0.7 to 20 at.% 1.7 to 270°K), 2:57127 (CALT-822-91)
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
NICKEL BASE ALLOYS/PHYSICAL RADIATION EFFECTS
Short-range order in disordered Fe-Ni alloys investigated by time-dependent perturbed angular correlation technique (Fast neutrons), 2:57144
NICKEL COMPLEXES/NEUTRON DIFFRACTION
Neutron diffraction studies of tetrahedral cluster transition metal hydride complexes: $HFeCO_3(CO)_9(P(OCH_3)_3)_9$ and $H_2Ni_4(C_5H_5)_4$, 2:57209 (BNL-22982)
NICKEL ORES/RESERVES
Canadian reserves of seven metals, 2:56933
NICKEL STEELS
(Steels containing only nickel as alloying element.)
NICKEL STEELS/ELASTICITY
The stress corrosion resistance and the cryogenic temperature mechanical properties of annealed Nitronic 60 bar material, 2:57115 (N-77-16149)
NICKEL STEELS/FRACTURE PROPERTIES
Effect of silicon on the environmental cracking behavior of a high strength steel (AISI 4340 and 300-M), 2:57114 (LBL-6012)
NICKEL STEELS/IMPACT STRENGTH
The stress corrosion resistance and the cryogenic temperature mechanical properties of annealed Nitronic 60 bar material, 2:57115 (N-77-16149)
NICKEL STEELS/YIELD STRENGTH
The stress corrosion resistance and the cryogenic temperature mechanical properties of annealed Nitronic 60 bar material, 2:57115 (N-77-16149)
NICKEL SULFIDES/CARCINOGENESIS
Mechanisms of dissolution of nickel subsulfide in rat serum, 2:57455
NICKEL-CADMIUM BATTERIES/PERFORMANCE TESTING
Testing of NiCd cells over geostationary orbit type cycling period, 2:56898 (N-77-10661)
NICKEL-ZINC BATTERIES/DESIGN
Researchers study new batteries, 2:56899
NICKEL-ZINC BATTERIES/PERFORMANCE TESTING
Researchers study new batteries, 2:56899
NIOBIUM/CRITICAL CURRENT
Pinning in niobium and vanadium single crystals containing hydrogen, 2:57162
NIOBIUM/ELECTRIC CONDUCTIVITY
Pinning in niobium and vanadium single crystals containing hydrogen, 2:57162
NIOBIUM/MAGNETIC FLUX
Pinning in niobium and vanadium single crystals containing hydrogen, 2:57162
NIOBIUM/PHYSICAL RADIATION EFFECTS
Low-temperature irradiation of niobium with 15-MeV neutrons, 2:57141 (CONF-770649-1)
NIOBIUM/SPUTTERING
Sputtering of niobium by energetic neutrons and protons: A round-robin experiment (MeV range), 2:57494
NIOBIUM/X-RAY FLUORESCENCE ANALYSIS
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57198 (LA-6869-MS)

Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57197 (LA-6869)
NIOBIUM 95/RADIOECOLOGICAL CONCENTRATION
Concentrations of radionuclides and selected stable elements in fruits and vegetables, 2:57381 (CONF-770676-1)
NIOBIUM ALLOYS
See also INCONEL 600
INCONEL 718
NIOBIUM BASE ALLOYS
NIOBIUM ALLOYS/COMPATIBILITY
Compatibility of bismuth and bismuth-lithium solutions with refractory metals and graphite, 2:57108 (CONF-760503-P2)
NIOBIUM ALLOYS/CORROSION
Corrosion of iron-base alloys by lithium, 2:57134 (CONF-760503-P2)
NIOBIUM ALLOYS/FABRICATION
Studies of design parameters in the fabrication of Nb-Al-Ge superconductors by the powder metallurgy infiltration method, 2:57091 (LBL-5772)
NIOBIUM ALLOYS/GRAIN GROWTH
Kinetics of formation of the A-15 phase in the Nb-Al-Ge system, 2:57105 (LBL-6266)
NIOBIUM ALLOYS/SUPERCONDUCTIVITY
Kinetics of formation of the A-15 phase in the Nb-Al-Ge system, 2:57105 (LBL-6266)
Studies of design parameters in the fabrication of Nb-Al-Ge superconductors by the powder metallurgy infiltration method, 2:57091 (LBL-5772)
NIOBIUM BASE ALLOYS/PHYSICAL RADIATION EFFECTS
Mechanism for the degradation of superconducting transition temperatures on high energy neutron radiation in A-15 compounds, 2:57125 (BNL-23053)
NIOBIUM BASE ALLOYS/TENSILE PROPERTIES
Influence of tensile stresses on the superconducting temperature of multifilamentary Nb_3Sn composite conductors, 2:57107 (BNL-23016)
NIOBIUM BASE ALLOYS/TRANSITION TEMPERATURE
Influence of tensile stresses on the superconducting temperature of multifilamentary Nb_3Sn composite conductors, 2:57107 (BNL-23016)
Mechanism for the degradation of superconducting transition temperatures on high energy neutron radiation in A-15 compounds, 2:57125 (BNL-23053)
NIOBIUM HYDRIDES/CRITICAL CURRENT
Pinning in niobium and vanadium single crystals containing hydrogen, 2:57162
NIOBIUM HYDRIDES/ELECTRIC CONDUCTIVITY
Pinning in niobium and vanadium single crystals containing hydrogen, 2:57162
NIOBIUM HYDRIDES/MAGNETIC FLUX
Pinning in niobium and vanadium single crystals containing hydrogen, 2:57162
NIOBIUM NITRIDES/QUENCHING
Effects of rapid quenching of superconductors, 2:57096
NIOBIUM NITRIDES/TRANSITION TEMPERATURE
Effects of rapid quenching of superconductors, 2:57096
NITINOL/SHAPE MEMORY EFFECT
Nitinol self-descaling surface for geothermal scale control, 2:56201 (LBL-6324)
NITINOL/USES
Nitinol self-descaling surface for geothermal scale control, 2:56201 (LBL-6324)
NITRATES/TRANSLOCATION
Simultaneous influx and efflux of nitrate during uptake by perennial ryegrass, 2:57418
NITRATES/UPTAKE
Nitrate uptake by dark-grown corn seedlings. Some characteristics of apparent induction, 2:57419
NITRIC OXIDE/CHEMICAL REACTION YIELD
Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, 11 September-10 December 1976 (5 refs), 2:55723 (FE-2018-6)
Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, December 11, 1976-March 10, 1977, 2:55724 (FE-2018-7)
Production of nitrogen compounds from molecular nitrogen in fuel-rich hydrocarbon-air flames, 2:57244
NITRIC OXIDE/REMOVAL
Catalytical removal of nitrogen oxide exemplified by a large plant, 2:55809
NITRILES/CHEMICAL RADIATION EFFECTS
Radiation-induced homolytic aromatic substitution. VI. The effect of metal ions on the hydroxylation of benzonitrile, anisole, and fluorobenzene, 2:57236
NITRILES/DIMERIZATION
Study of dimerization in acetonitrile vapor by measurement of thermal conductivity (338-387°K, 100-1050 torr), 2:57231
NITRILES/HYDROXYLATION
Radiation-induced homolytic aromatic substitution. VI. The effect of metal ions on the hydroxylation of benzonitrile, anisole, and fluorobenzene, 2:57236
NITRILES/THERMAL CONDUCTIVITY
Study of dimerization in acetonitrile vapor by measurement of thermal conductivity (338-387°K, 100-1050 torr), 2:57231
NITRITES
See NITROUS ACID
NITRO COMPOUNDS/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
NITROGEN/CORROSIVE EFFECTS
Corrosion of ferrous alloys in nitrogen contaminated liquid lithium, 2:57133 (CONF-760503-P1)
NITROGEN/DIELECTRIC PROPERTIES
Electrical breakdown and tracking characteristics of pulsed high voltages in cryogenic helium and nitrogen, 2:57742
NITROGEN/ELECTRON COLLISIONS
Angular correlation of electrons coming from ionization by electron impact (Reviews), 2:57527
NITROGEN 14/TRANSLOCATION
Simultaneous influx and efflux of nitrate during uptake by perennial ryegrass, 2:57418
NITROGEN 15/BIOLOGICAL EFFECTS
Isotope chemistry and biology, 2:57438
NITROGEN 15/TRANSLOCATION
Simultaneous influx and efflux of nitrate during uptake by perennial ryegrass, 2:57418
NITROGEN DIOXIDE/ENERGY LEVELS
Theoretical studies of the atmospheric triatomic molecules H_2O, N_2O, NO_2, CO_2, O_3, and their ions, 2:57501 (ANL-77-3)
NITROGEN HYDRIDES/CHEMICAL REACTION YIELD
Production of nitrogen compounds from molecular nitrogen in fuel-rich hydrocarbon-air flames, 2:57244
NITROGEN OXIDES
See also NITRIC OXIDE
NITROGEN DIOXIDE
NITROUS OXIDE
NITROGEN OXIDES/BIOLOGICAL EFFECTS
Nitrogen oxides. Environmental health effects research series, 2:57457 (PB-264872)
NITROGEN OXIDES/HEALTH HAZARDS
Control of the level of NO/sub x/ in the indoor environment, 2:57459 (CONF-770557-2)
NITROGEN OXIDES/REMOVAL
Removal of contaminants from industrial gaseous effluents, 2:55654
NITROGEN OXIDES/YIELDS
Investigation of the effect of nitrogen-containing fuel additives on the formation of nitrogen oxides, 2:55805
NITROSO COMPOUNDS/CRYSTAL STRUCTURE
Novel co-ordination of sulphur dioxide. The crystal and molecular structure of nitrosyl(sulfur dioxide)bis(triphenylphosphine)rhodium, 2:57233
NITROSO COMPOUNDS/SYNTHESIS
Novel co-ordination of sulphur dioxide. The crystal and molecular structure of nitrosyl(sulfur dioxide)bis(triphenylphosphine)rhodium, 2:57233
NITROUS ACID/DECOMPOSITION
Mechanism of nitrous acid decomposition, 2:57217 (ORNL-tr-4405)
NITROUS OXIDE/ATOM-MOLECULE COLLISIONS
Crossed molecular beams kinetics: BaO recoil velocity spectra from $Ba + N_2O$, 2:57511
NITROUS OXIDE/ENERGY LEVELS
Theoretical studies of the atmospheric triatomic molecules H_2O, N_2O, NO_2, CO_2, O_3, and their ions, 2:57501 (ANL-77-3)
NONDESTRUCTIVE TESTING
Technique for measuring optical fiber transmission using the time dispersion of Cerenkov radiation, 2:57309
NON-EQUILIBRIUM PLASMA/PLASMA INSTABILITY
Development of two- and three-dimensional perturbations in the case of an ionization instability in a channel with nonconducting walls, 2:57672
NONMETALS
See also PHOSPHORUS
NONMETALS/CHEMICAL ANALYSIS
Specimen equilibration device (or multipurpose sampler) for the analysis of nonmetals in liquid sodium, 2:57195 (RDT-C-8-8T(7-77))
NORTH DAKOTA/COAL DEPOSITS
Preliminary report on 1975 drilling of lignites in western North Dakota: Adams, Bowman, Dunn, Hettinger, McLean, Mercer, Oliver, Slope, and Williams Counties, 2:55661 (USGS-OFR-76-869)
NORTH SEA/NATURAL GAS DISTRIBUTION SYSTEMS
Pipeline system for more natural gas from the North Sea, 2:55820

NORTH SEA/OFFSHORE OPERATIONS
Planning and laying of Cormorant pipeline, 2:55796
Recent new oil sources and their implications for world energy, 2:55760
NORTH SEA/OIL FIELDS
Recent new oil sources and their implications for world energy, 2:55760
NORTH SEA/PETROLEUM INDUSTRY
Dynamics of petroleum industry investment in the North Sea. (World Oil Project), 2:56971 (PB-265093)
NORTHERN IRELAND
See UNITED KINGDOM
NOZZLES/CRACKS
Corner crack at a nozzle, 2:56672
Fatigue and fracture behaviour of cracks at nozzle corners: comparison of theoretical predictions with experimental data, 2:57260
NOZZLES/DESIGN
Novel design for LWR pressure vessel nozzles and corresponding stress analysis, 2:56383
NOZZLES/FATIGUE
Fatigue and fracture behaviour of cracks at nozzle corners: comparison of theoretical predictions with experimental data, 2:57260
NOZZLES/STRESS ANALYSIS
Fatigue and fracture behaviour of cracks at nozzle corners: comparison of theoretical predictions with experimental data, 2:57260
Novel design for LWR pressure vessel nozzles and corresponding stress analysis, 2:56383
NUCLEAR ACCIDENTS
See ACCIDENTS
NUCLEAR DATA COLLECTIONS/ERRORS
Data covariance files for ENDF/B-V, 2:57622 (ORNL/TM-5938)
NUCLEAR ENERGY/COMPARATIVE EVALUATIONS
Health hazards of not going nuclear, 2:56938
NUCLEAR ENERGY/ENERGY POLICY
Emerging role of FEA in nuclear energy expansion, 2:56939
NUCLEAR ENERGY/HEALTH HAZARDS
Health hazards of not going nuclear, 2:56938
NUCLEAR ENERGY/TECHNOLOGY ASSESSMENT
Health hazards of not going nuclear, 2:56938
NUCLEAR ENGINEERING/DATA ACQUISITION SYSTEMS
Computer-based data acquisition system for a multistation teaching laboratory, 2:56619
NUCLEAR ENGINEERING/EDUCATION
Code to assist in teaching nuclear fuel management, 2:56622
Computer-based data acquisition system for a multistation teaching laboratory, 2:56619
Computer modules in the nuclear engineering laboratory, 2:56620
Cooperative education at one utility, 2:56624
Cooperative nuclear engineering-utility programs at North Carolina State University, 2:56625
Development of the Nuclear Engineering Laboratory of Ecole Polytechnique, 2:56617
Development of the undergraduate nuclear engineering co-op program at Cincinnati, 2:56628
Expanding nuclear engineering student knowledge horizons using the laboratory, 2:56618
Incorporation of commercial reactor codes into a nuclear engineering course, 2:56621
Industrial internship program in nuclear engineering education, 2:56627
Interaction between utilites and the university, 2:56626
Process instrumentation measurements for nuclear engineering laboratories, 2:56615
Role of nuclear laboratory courses at Purdue University, 2:56616
Teaching project management as part of international technology, 2:56623
Three year's experience with a graduate nuclear engineering co-op program, 2:56629
NUCLEAR FACILITIES
See also FUEL FABRICATION PLANTS
FUEL REPROCESSING PLANTS
NUCLEAR FACILITIES/DESIGN
Role of the engineer in protecting personnel and the environment in the nuclear industry, 2:57273 (MLM-2438(OP))
NUCLEAR FACILITIES/SAFEGUARDS
Physical protection of nuclear facilities. Quarterly progress report, January-March 1977, 2:55963 (SAND-77-0999)
Safeguards system design methodology, 2:55961 (SAND-77-0890C)
NUCLEAR FUELS
See also FUEL ELEMENTS
FUEL SLURRIES
LIQUID FUELS
SOLID FUELS
SPENT FUELS
NUCLEAR FUELS/ACCOUNTING
Financing and accounting for nuclear fuel: a problem of unknown certainty, 2:56603
Nuclear fuel accounting practice at Duke Power Company, 2:56604
NUCLEAR FUELS/RADIOACTIVITY
PURSE: plutonium radiation source code, 2:55868 (PNCT-841-75-37)
NUCLEAR FUELS/REGULATIONS
Regulatory issues in nuclear fuel accounting and rate making, 2:56589
NUCLEAR MATERIALS MANAGEMENT
Evaluation of safeguards systems for nuclear material in transit: the development of the program plan. Winter 1977 quarterly report, 2:55964 (SAND-77-8249)
NUCLEAR MATERIALS MANAGEMENT/ACCOUNTING
Estimates and sampling schemes for the instrumentation of accountability systems, 2:55902 (UCRL-13733-1)
Study of nuclear material accounting. Final report, July 1, 1976-April 1, 1977, 2:55956 (NUREG-0290(Vol.1))
Study of nuclear material accounting. Final report, July 1, 1976-April 1, 1977, 2:55957 (NUREG-0290(Vol.2))
Study of nuclear material accounting. Final report, July 1, 1976-April 1, 1977, 2:55958 (NUREG-0290(Vol.3))
Uranium accountability for ATR fuel fabrication. Part I. A description of the existing system, 2:55965 (TREE-1145)
NUCLEAR MATERIALS MANAGEMENT/ALARM SYSTEMS
Automatic duress alarms through physiological response monitoring, 2:55960 (SAND-77-0191)
NUCLEAR MATERIALS MANAGEMENT/EVALUATION
Material control assessment procedure, 2:55966 (UCRL-79214)
NUCLEAR MATERIALS MANAGEMENT/MATERIAL UNACCOUNTED FOR
Report on strategic special nuclear material inventory differences (Jan. 1, 1968-Sept. 30, 1976), 2:55959 (NUREG-0350(Vol.1)(No.1))
NUCLEAR MATERIALS MANAGEMENT/SYSTEMS ANALYSIS
Material control assessment procedure, 2:57384 (UCRL-79214(Rev.1))
NUCLEAR MEDICINE
See also SCINTISCANNING
NUCLEAR MEDICINE/IMAGE PROCESSING
Digital modeling of a zone plate, gamma-ray imaging system, 2:57424
Role of midi-maxi computer interaction in nuclear medicine, 2:57423
NUCLEAR PARKS/ECONOMIC IMPACT
Some public finance aspects of nuclear energy centers. State and local public finance problems and prospects: Some implications of nuclear energy centers, 2:56935 (PB-264611)
NUCLEAR PARKS/FINANCING
Some public finance aspects of nuclear energy centers. State and local public finance problems and prospects: Some implications of nuclear energy centers, 2:56935 (PB-264611)
NUCLEAR PARKS/FUEL CYCLE
Alternative fuel cycle for Nuclear Energy Centers, 2:56601
NUCLEAR PARKS/SITE SELECTION
Siting studies for an asymptotic U.S. energy supply system based primarily on nuclear energy, 2:56361 (CONF-770441-2)
NUCLEAR POWER/ECONOMICS
Economic viability of nuclear energy. A seminar for members of Congress and their staffs, 2:56590 (CONF-7606151-)
NUCLEAR POWER/ENERGY POLICY
Can we do without uranium, 2:56936
NUCLEAR POWER/GLOBAL ASPECTS
Use of coal in power plants, 2:56978
NUCLEAR POWER/MEETINGS
Transactions of the American Nuclear Society 1977 annual meeting, New York, NY, June 12-16, 1977, 2:57804
NUCLEAR POWER/PLANNING
Nuclear power industry in the tenth five-year plan period (USSR), 2:56390
NUCLEAR POWER PLANTS
See also UNDERGROUND NUCLEAR STATIONS
NUCLEAR POWER PLANTS/AIR CLEANING SYSTEMS
Method for the arrangement of activated carbon adsorption tower (Patent), 2:56701
NUCLEAR POWER PLANTS/AUXILIARY WATER SYSTEMS
Water supply system (Patent), 2:56705
NUCLEAR POWER PLANTS/AVAILABILITY
Action Plan for improving power plant productivity (Comparison of two nuclear and two coal-fired plants), 2:56594 (PB-264565)
Power plant productivity. Analysis report (Comparison of two nuclear and two coal-fired plants), 2:56591 (PB-264467)
Power plant productivity: an assessment of outages at two coal-fired and two nuclear plants, 2:56593 (PB-264564)

Productivity improvement action plan, 2:56592 (PB-264468)
NUCLEAR POWER PLANTS/BUILDINGS
First-rate prestressed concrete structures in underground workings: oceanic buildings, nuclear power plants, containers and tunnels, 2:56706
NUCLEAR POWER PLANTS/CONDENSATES
Experience of industrial operation of wash-in cartridge filters in chemical water purification schemes of nuclear power plants, 2:56686
NUCLEAR POWER PLANTS/CONSTRUCTION
Effect of land value on construction costs of thermal and nuclear power plants, 2:56365
NUCLEAR POWER PLANTS/CONTAINMENT SHELLS
Fracture toughness of welded joints of ASTM A543 steel plate, 2:56674
Prospects of improving pearlitic steels for reactor shells and other equipment of the first loop of nuclear power plants, 2:56694
NUCLEAR POWER PLANTS/CONTROL
Investigation of operating conditions of nuclear power plants during emergency shortages of power in the electric power system, 2:56389
NUCLEAR POWER PLANTS/COOLING TOWERS
Cooling tower feedwater treatment for nuclear power plants, 2:56663
NUCLEAR POWER PLANTS/COST
Effect of land value on construction costs of thermal and nuclear power plants, 2:56365
NUCLEAR POWER PLANTS/DECOMMISSIONING
Radiological criteria for release of land and for decommissioning facilities, 2:56588
NUCLEAR POWER PLANTS/DESIGN
Realistic seismic safety for nuclear plants, 2:56745
NUCLEAR POWER PLANTS/DISTRICT HEATING
Principles of nuclear district heating, 2:56611
NUCLEAR POWER PLANTS/ENERGY POLICY
Economic and environmental implications of a U.S. nuclear moratorium, 1985-2010, 2:56741 (ORAU/IEA-76-4)
NUCLEAR POWER PLANTS/ENGINEERED SAFETY SYSTEMS
On the probability of loss of dc power following ac failure in a nuclear power plant, 2:56791 (PB-265099)
NUCLEAR POWER PLANTS/ENVIRONMENTAL IMPACTS
Atmospheric impacts of wet cooling systems for power plants, 2:56752
Engineer's opinion of the Vermont Yankee court decision, 2:56742
Impact and fate on aquatic environments of copper from nuclear power plants, 2:57446
Power plant impact on chemical quality of surface and groundwaters, 2:57395
NUCLEAR POWER PLANTS/FAULT TREE ANALYSIS
Automatic event tree construction, 2:56865
DICOMICS-TWIN: self-adaptive algorithm for minimal cut sets determination from fault trees, 2:56866
Modular approach to fault tree and reliability analysis, 2:56867
NUCLEAR POWER PLANTS/FEEDWATER
Experience of industrial operation of wash-in cartridge filters in chemical water purification schemes of nuclear power plants, 2:56686
Investigation of magnetic filters for iron removal from feedwater of steam generators at nuclear power plants, 2:56687
NUCLEAR POWER PLANTS/FIRE PREVENTION
Preventive fire protection measures in nuclear power plants, 2:56869
NUCLEAR POWER PLANTS/FUEL CYCLE
Economic computations in the fuel cycle (Allocated costs and discounted cash flow computations), 2:56596
Educational aspects of reactor calculations for fuel management, 2:56597
NUCLEAR POWER PLANTS/FUEL MANAGEMENT
Nuclear fuel accounting practice at Duke Power Company, 2:56604
Nuclear inventory and management system (NIMS): a program for nuclear fuels accounting, 2:56605
NUCLEAR POWER PLANTS/FUEL POOLS
Comparing structural loads in large pools evaluated with the LUSH code and current design methods, 2:56796 (UCRL-79277)
NUCLEAR POWER PLANTS/HEAT EXCHANGERS
Explosive plugging of nuclear heat exchangers, 2:56679
Properties of explosive-welded Monel-clad steels, 2:56680
NUCLEAR POWER PLANTS/LEGAL ASPECTS
Economic and environmental implications of a U.S. nuclear moratorium, 1985-2010, 2:56741 (ORAU/IEA-76-4)
Engineer's opinion of the Vermont Yankee court decision, 2:56742
NUCLEAR POWER PLANTS/MELTDOWN
Some probabilistic aspects of the seismic risk of nuclear reactors, 2:56789 (PB-265020)
NUCLEAR POWER PLANTS/PIPE FITTINGS
Square through tube (Patent), 2:56699
NUCLEAR POWER PLANTS/PIPE JOINTS
New and advanced technological process of manufacture of connecting pipes on frames of nuclear power plants by electroslag welding, 2:57097
NUCLEAR POWER PLANTS/PIPES
Contributions of the ORNL piping program to nuclear piping design codes and standards, 2:56662
Fracture in straight pipes under large deflection conditions. I. Structural deformations, 2:56661
NUCLEAR POWER PLANTS/POWER SUPPLIES
Failure probability of the battery system following loss of ac power, 2:56862
NUCLEAR POWER PLANTS/POWER SYSTEMS
Investigation of operating conditions of nuclear power plants during emergency shortages of power in the electric power system, 2:56389
NUCLEAR POWER PLANTS/PRESSURE VESSELS
Corner crack at a nozzle, 2:56672
Cyclic stress strain behavior of four nuclear pressure vessel materials, 2:56676
Failure assessment of pressure vessels under yielding conditions, 2:56675
Initiation and arrest: two approaches to pressure vessel safety, 2:56873
Manufacture of multi-layered casings of stationary apparatus and problems of their strength, 2:56695
Pressure vessel technology. I. Analysis, design, and inspection, 2:56667
Pressure vessel technology. II. Materials and fabrication, 2:56671
NUCLEAR POWER PLANTS/PUMPS
Effect of the frequency of rotation on the efficiency of a centrifugal pump with a low n/sub s/, 2:56684
Feed pump drives - a cost comparison between steam turbine and electric-driven propulsion, 2:56683
Rectifier motor as a drive for axial pumps, 2:56693
NUCLEAR POWER PLANTS/QUALITY ASSURANCE
Nuclear projects quality assurance program for design, construction, and preoperational testing. Revision 1. Attachment 2. Responses to NRC request for additional information for PGE topical report, PGE-8003, 2:56587 (PGE-8003(Rev.1)(Att.2))
NUCLEAR POWER PLANTS/RADIATION HAZARDS
Peaceful utilization of nuclear energy: effects on the policy of security in the Federal Republic, 2:56882 (ERDA-tr-273)
NUCLEAR POWER PLANTS/RADIOACTIVE EFFLUENTS
AEOLUS: atmospheric dispersion and finite-cloud doses during normal, sea-breeze, and accident conditions, 2:57372
Probabilistic prediction of X/Q for routine intermittent gaseous releases, 2:57373
Remote monitoring system for nuclear reactors, 2:56751
NUCLEAR POWER PLANTS/RADIOACTIVE WASTE MANAGEMENT
But what will be done with the high level radioactive waste. Surely man can improve on nature, 2:56934
NUCLEAR POWER PLANTS/REACTOR ACCIDENTS
Selecting probability for use in direction-dependent accident dispersion models consistent with past NRC practice, 2:56858
NUCLEAR POWER PLANTS/REACTOR COMPONENTS
Determination of equivalent response cycles for use in earthquake-induced fatigue analyses, 2:56793 (SAN/1011-106)
NUCLEAR POWER PLANTS/REACTOR CONTROL SYSTEMS
Safe operation of power plants. Pt. 1. State of technology concerning electrotechnical and control equipment in thermal power plants, 2:56728
Safe operation of power plants. Pt. 2 . Technical means for the optimal operation of nuclear power plants, 2:56729
NUCLEAR POWER PLANTS/REACTOR COOLING SYSTEMS
Leakage detecting apparatus in an atomic power plant (Patent), 2:56703
Usefulness and methods of periodic treatment of extrareactor part of single-loop nuclear power plants, 2:56682
NUCLEAR POWER PLANTS/REACTOR LICENSING
Environmental planning and the siting of nuclear facilities: the integration of water, air, coastal, and comprehensive planning into the nuclear siting process. Improving regulatory effectiveness in federal/state siting actions, 2:56582 (NUREG-0199)
Nuclear power plant licensing: opportunities for improvement, 2:56583 (NUREG-0292)
Power Reactor Docket Information, 2:56584 (NUREG/PRDI-77/4)
NUCLEAR POWER PLANTS/REACTOR OPERATION
Advanced methodology and systems for power plant pathology, 2:56595
Investigation of operating conditions of nuclear power plants during emergency shortages of power in the electric power system, 2:56389

Nuclear power plant operating experience, 1974-1975, 2:56586 (PB-265794)
Nuclear power plants 1976 - international VGB congress at Stuttgart, September 7 to 10, 1976, 2:56366
Operating U.S. power reactors, 2:56382
NUCLEAR POWER PLANTS/REACTOR SAFETY
Data and assessment of human factor impact on nuclear reactors, 2:56860
How safe, 2:56870
Report to Congress on abnormal occurrences, July-September 1976. Quarterly report, Jul-Sep 1976, 2:56585 (PB-265676)
NUCLEAR POWER PLANTS/REACTOR SITES
Data for the evaluation of the properties of sites for nuclear power plants in consideration of reactor safety and radiation protection (German Federal Republic), 2:56749 (NP-tr-1974)
Guidelines for estimating present and forecasting future population distributions surrounding power reactor sites. (Draft of a standard) (USA), 2:56743 (EPRI-EA-427-SR)
NUCLEAR POWER PLANTS/RETROFITTING
Technical re-equipment of nuclear power engineering and boiler engineering plants, 2:56666
NUCLEAR POWER PLANTS/SABOTAGE
Safety and security of nuclear power reactors to acts of sabotage, 2:56396
NUCLEAR POWER PLANTS/SECURITY
Safety and security of nuclear power reactors to acts of sabotage, 2:56396
NUCLEAR POWER PLANTS/SEISMIC EFFECTS
Assessment of soil/structure interaction analysis procedures for nuclear power plant structures, 2:56871
Determination of equivalent response cycles for use in earthquake-induced fatigue analyses, 2:56793 (SAN/1011-106)
Equivalent viscous damping for seismic analyses of nuclear plants, 2:56792 (SAN/1011-103)
Nonlinear characteristics of liquid sloshing in rigid tanks, 2:56872
NUCLEAR POWER PLANTS/SITE SELECTION
Environmental planning and the siting of nuclear facilities: the integration of water, air, coastal, and comprehensive planning into the nuclear siting process. Improving regulatory effectiveness in federal/state siting actions, 2:56582 (NUREG-0199)
INSITE: information on nuclear sites data system, 2:56746
Recent state laws regulating power facility siting, 2:56748
NUCLEAR POWER PLANTS/SOCIO-ECONOMIC FACTORS
Economic and environmental implications of a U.S. nuclear moratorium, 1985-2010, 2:56741 (ORAU/IEA-76-4)
Social aspects of nuclear power plant siting, 2:56747
NUCLEAR POWER PLANTS/SPENT FUEL STORAGE
HI-CAP high-capacity fuel rack design, 2:56656
Spent fuel storage basis for new nuclear power plants, 2:55892
NUCLEAR POWER PLANTS/STEAM CONDENSERS
Development and tests of a condenser/degasser designed by VTI for special water purification systems of nuclear power plants, 2:56681
NUCLEAR POWER PLANTS/STEAM SYSTEMS
Steam-flow and seismic tests of nuclear ball valves verify design and fabrication, 2:56660
Using sliding live steam pressure to control the capacity of power units of nuclear power plants, 2:56664
NUCLEAR POWER PLANTS/STEAM TURBINES
Analysis of the control system of a high-capacity turbine for a nuclear power plant, 2:56735
Apparatus for controlling vapor temperature in a nuclear power plant (Patent), 2:56697
Fatigue damage on large components, 2:56692
Heat treatment of large-sized welded steam turbine rotors for nuclear power plants, 2:56268
Selection and investigation of turbine capacity control system for nuclear power plants, 2:56730
State of the art and trends in the development of foreign turbine construction for nuclear power plants, 2:56696
NUCLEAR POWER PLANTS/THERMOCHEMICAL HEAT STORAGE
Chemical methods of storing thermal energy, 2:56155
NUCLEAR POWER PLANTS/VALVES
Advances in small zero-leak valves point to better nuclear power-plant reliability, 2:56657
Leakage control device in a main steam isolating valve (Patent), 2:56702
NUCLEAR POWER PLANTS/WASTE HEAT
Characterization of industrial process heat, including the potential for solar or nuclear systems to supply this market, 2:56094
NUCLEAR REACTORS
See REACTORS
NUCLEAR SHIPS/ACCIDENTS
Probabilistic assessment of collisions involving nuclear vessels, 2:56765
NUCLEAR STRUCTURE
Limits of nuclear stability, 2:57615
NUCLEAR STRUCTURE/FORM FACTORS
Calculation of nuclear form factors by the method of hyperspherical functions, 2:57614
NUCLEAR STRUCTURE/HARTREE-FOCK METHOD
Hartree-Fock method with an effective interaction that depends on the density and on the self-consistency condition, 2:57616
NUCLEASE (DEOXYRIBONUCLEASE)
See DNA-ASE
NUCLEASES/BIOCHEMISTRY
DNA replication of the parvovirus Kilham rat virus. I. Characterization of intracellular forms of viral DNA extracted by guanidine hydrochloride, 2:57410 (CONF-770555-2)
Double-helical regions in Kilham rat virus DNA, 2:57409 (CONF-770555-1)
NUCLEATE BOILING
Improved nucleate boiling design equation, 2:56648
NUCLEI/DECAY
Decaying states (Review), 2:57619
NUCLEI/MASS FORMULAE
Limits of nuclear stability, 2:57615
NUCLEI/STABILITY
Limits of nuclear stability, 2:57615
NUCLEON-NUCLEON POTENTIAL/INVERSE SCATTERING PROBLEM
Singlet even nucleon-nucleon potentials obtained by an algebraic method for the inverse problem of scattering theory (60 to 120 MeV (c.m.)), 2:57590
NUTS
See FASTENERS

O

OBRIGHEIM REACTOR/PRIMARY COOLANT CIRCUITS
Inservice inspections of primary components on the nuclear power plant Obrigheim, 2:56417
OCCIDENTAL FLASH PYROLYSIS PROCESS
Properties of coal liquids produced by the Occidental flash pyrolysis process (4 refs), 2:55618 (CONF-760885-)
OCEAN THERMAL POWER PLANTS/BIOLOGICAL FOULING
Heat transfer problems in an ocean thermal power plant, 2:56090 (COO-4041-2)
OCEAN THERMAL POWER PLANTS/ENERGY TRANSPORT
Alternative energy transmission systems from OTEC plants. Project 8980 third quarter progress report, January 1-March 31, 1977 (Study on 4 thermal storage systems), 2:56091 (DSE/2426-12)
Alternative forms of energy transmission from OTEC plants (Chemical and electrical), 2:56089 (CONF-770331-5)
OCEAN THERMAL POWER PLANTS/HEAT EXCHANGERS
Heat transfer problems in an ocean thermal power plant, 2:56090 (COO-4041-2)
OCEANS
See SEAS
OFFICE BUILDINGS/SOLAR AIR CONDITIONING
The design of a solar energy collection system to augment heating and cooling for a commercial office building, 2:56098 (N-77-16446)
OFFICE BUILDINGS/SOLAR SPACE HEATING
The design of a solar energy collection system to augment heating and cooling for a commercial office building, 2:56098 (N-77-16446)
OFF-PEAK ENERGY STORAGE/ELECTRIC BATTERIES
Batteries for the '80s: the materials of energy storage, 2:56890
OFF-PEAK ENERGY STORAGE/PLANNING
Energy storage in the form of latent heat, 2:56388
OFF-PEAK ENERGY STORAGE/SODIUM-SULFUR BATTERIES
Sodium-sulfur battery, 2:56893
OFFSHORE NUCLEAR POWER PLANTS/CONTAINMENT SHELLS
Stress analysis of partial sphere used for bottom shell of off-shore structure, 2:56691
OFFSHORE NUCLEAR POWER PLANTS/ENVIRONMENTAL IMPACTS
Offshore environmental monitoring program for a proposed nuclear power plant in Islote, Puerto Rico: operations and planning, 2:56753
OFFSHORE PLATFORMS/DESIGN
Articulated loading platform (ALP), 2:55800
Safety aspects in offshore design, 2:55780
OFFSHORE PLATFORMS/DYNAMIC LOADS
Scaling of fixed off-shore structures, 2:57330
OFFSHORE PLATFORMS/INSTALLATION
Method and apparatus for connecting two or more components of an offshore platform (Patent), 2:55759

OFFSHORE PLATFORMS/MECHANICAL VIBRATIONS
Scaling of fixed off-shore structures, 2:57330
OFFSHORE PLATFORMS/SAFETY
Safety aspects in offshore design, 2:55780
OFFSHORE PLATFORMS/SAFETY ENGINEERING
Safety aspects in offshore design, 2:55780
OFFSHORE PLATFORMS/SCALING LAWS
Scaling of fixed off-shore structures, 2:57330
OFFSHORE PLATFORMS/TESTING
Articulated loading platform (ALP), 2:55800
OFFSHORE SITES/MONITORING
Offshore environmental monitoring program for a proposed nuclear power plant in Islote, Puerto Rico: operations and planning, 2:56753
OIL FIELDS/OFFSHORE OPERATIONS
DEROCS: a computer program to simulate offshore oil and natural gas development scenarios and onshore service base requirements, 2:55757 (USGS-OFR-77-130)
OIL FIELDS/SEISMIC EFFECTS
Seismicity and faulting attributable to fluid extraction, 2:55794
OIL FIELDS/SPATIAL DISTRIBUTION
Predicting oil and gas potential from tectonic conditions of distribution of oil and gas fields in west Pre-caucasus, 2:55743
OIL SANDS/ELECTROCARBONIZATION
Electrofrac's secondary oil recovery systems, 2:55756 (NP-22197)
OIL SANDS/IN-SITU PROCESSING
Method of in situ recovery of viscous oils and bitumens (Patent), 2:55838
OIL SANDS/IN-SITU RETORTING
Importance of reservoir description in evaluating in-situ recovery methods for Cold Lake heavy oil. I. Reservoir description, 2:55842
Importance of reservoir description in evaluatiang in-situ recovery methods for Cold Lake heavy oil. II. In-situ application, 2:55841
OIL SANDS/PROCESSING
Status of tar sands conversion process technology and residuals management, 2:55833 (CONF-7605160-1)
OIL SHALE DEPOSITS/EXPLOSIVE FRACTURING
In situ oil shale fracturing experiment: some preliminary results, 2:55831 (SAND-77-0422C)
OIL SHALE DEPOSITS/GEOCHEMICAL SURVEYS
Geochemical provinces revealed in Toarcian oil shales in the eastern Paris Basin. Analysis of the soluble organic fraction, 2:55830
OIL SHALE INDUSTRY
See also MINERAL INDUSTRY
OIL SHALE INDUSTRY/ENVIRONMENTAL IMPACTS
Oil shale development in northwestern Colorado: water and related land impacts. Water resources management workshop, 2:55851 (IES-48)
OIL SHALE INDUSTRY/SOCIO-ECONOMIC FACTORS
Oil shale development in northwestern Colorado: water and related land impacts. Water resources management workshop, 2:55851 (IES-48)
OIL SHALE PROCESSING PLANTS
Method for extracting oil from oil shale (Patent), 2:55843
OIL SHALES/CHEMICAL COMPOSITION
Nitrogenous substances of kerogen in Estonian dictyonemic shales, 2:55846
OIL SHALES/ELECTROCARBONIZATION
Electrofrac's secondary oil recovery systems, 2:55756 (NP-22197)
OIL SHALES/EXPLOSIVE FRACTURING
Stress waves measured and calculated for in situ explosive rubblization experiments in oil shale, 2:55832 (SAND-77-0779C)
OIL SHALES/FLUID INJECTION
Hydrothermally forming a flow barrier in a leached subterranean oil shale formation (Patent), 2:55839
OIL SHALES/FLUID INJECTION PROCESSES
Producing shale oil by flowing hot aqueous fluid along vertically varied paths within ieached oil shale (Patent), 2:55840
OIL SHALES/IN-SITU RETORTING
Modified in-situ oil shale technology at the Lawrence Livermore Laboratory: experimental results and present status, 2:55837 (UCRL-79149)
OIL SHALES/MODIFIED IN-SITU PROCESSES
Modified in-situ oil shale technology at the Lawrence Livermore Laboratory: experimental results and present status, 2:55837 (UCRL-79149)
OIL SHALES/OIL YIELDS
Rapid method for source rock characterization and for determination of their petroleum potential and degree of evolution, 2:55746
OIL SHALES/PROCESSING
Method for extracting oil from oil shale (Patent), 2:55843
OIL SHALES/QUANTITATIVE CHEMICAL ANALYSIS
Quantitative determination of dawsonite in Green River shale by powder-sample x-ray diffraction: effect of grinding, 2:55848
OIL SHALES/RETORTING
Dynamics of oil generation and degradation during retorting of oil shale blocks and powders, 2:55836 (UCRL-79034)
Oil shale retorting. Part I. The effects of particle size and heating rate on oil evolution and intraparticle oil degradation, 2:55835 (UCRL-52256(Pt.1))
OIL SHALES/REVIEWS
Shale tomorrow. I. The world situation, 2:55829
OIL SPILLS
Oil spill and oil pollution reports, May 1976-July 1976. Quarterly report, 2:55792 (PB-264870)
OIL SPILLS/ENVIRONMENTAL IMPACTS
Continuous spilling of hot oil on ice, 2:55793
OIL SPILLS/MATHEMATICAL MODELS
Continuous spilling of hot oil on ice, 2:55793
OIL WELLS
See also PETROLEUM
OIL WELLS/ELECTRIC HEATING
Electrofrac's secondary oil recovery systems, 2:55756 (NP-22197)
OIL WELLS/FLUID INJECTION
Stability of the replacement of a non-Newtonian fluid layer in a porous medium, 2:55765
OIL WELLS/GAS INJECTION
Rock-fluid relationship studies on the Windfall D-3A reservoir and their application in evaluatiang gas cycling effectiveness, 2:55744
OIL WELLS/MICROEMULSION FLOODING
Performance of the Taber South polymer flood, 2:55763
OIL WELLS/MISCIBLE-PHASE DISPLACEMENT
Tertiary oil recovery by CO_2 injection. Quarterly report, October-December 1976, 2:55755 (FE-5302-5)
OIL WELLS/OFFSHORE PLATFORMS
Advanced drillship for deep water operations, 2:55761
OIL WELLS/PLUGGING
Plugging techniques that should allow mining through wells. Final report, 2:55779 (MERC/RI-77/1)
OIL WELLS/STEAM INJECTION
Thermal insulating fluid (Patent), 2:55767
OIL WELLS/WATERFLOODING
Description of the waterflooding computation methods for oil fields, 2:55762
OIL-IMPORTING COUNTRIES/INVESTMENT
Accommodation in the international capital markets and the recycling of oil funds. Working paper, 2:56917 (PB-265113)
OIL-IMPORTING COUNTRIES/TRADE
Accommodation in the international capital markets and the recycling of oil funds. Working paper, 2:56917 (PB-265113)
OKG-1 REACTOR/POWER DENSITY
Okarshamn Reactor, Unit 1. Ramp test program, 2:56407 (NP-tr-1979)
OKLAHOMA/GEOLOGICAL SURVEYS
Seismicity and tectonic relationships of the Nemaha Uplift in Oklahoma, Kansas, and Nebraska, 2:57473
OLEFINS
See ALKENES
OMEGA-784 RESONANCES/PARTICLE PRODUCTION
Investigation of rho°- and ω-meson production in π^-p interactions at 40 GeV/c, 2:57571
ON-LINE CONTROL SYSTEMS/DESIGN
Reactor control system (Patent), 2:56736
ON-LINE MEASUREMENT SYSTEMS
Ultrasonic data acquisition, analysis, and display by minicomputer aided techniques, 2:57308 (SAND-77-0526C)
ONTARIO PHWR PICKERING-3 REACTOR
See PICKERING-3 REACTOR
ONTARIO PHWR PICKERING-4 REACTOR
See PICKERING-4 REACTOR
OPEC
(Organization of Petroleum Exporting Countries.)
OPEC/INVESTMENT
Accommodation in the international capital markets and the recycling of oil funds. Working paper, 2:56917 (PB-265113)
OPEC/TRADE
Accommodation in the international capital markets and the recycling of oil funds. Working paper, 2:56917 (PB-265113)
OPEC and the monopoly price of world oil (World Oil Project). Working paper, 2:56970 (PB-265015)
ORBITAL SOLAR POWER PLANTS/ECONOMICS
Initial technical environmental, and economic evaluation of space solar power concepts. volume 2: detailed report, 2:56077 (N-77-16443)
ORBITAL SOLAR POWER PLANTS/FEASIBILITY STUDIES
Astronautical energy solution, 2:56082
Initial technical, environmental, and economic evaluation of space solar power concepts. volume 1: summary, 2:56076 (N-77-16442)
ORBITAL SOLAR POWER PLANTS/MICROWAVE POWER TRANSMISSION
Astronautical energy solution, 2:56082

ORBITAL SOLAR POWER PLANTS/RESEARCH PROGRAMS
Space-based power conversion and power relay systems: preliminary analysis of alternate systems. Interim report, 8 Jul. 1975 - 26 May 1976, 2:56080 (N-77-16447)
ORC FLASH PYROLYSIS PROCESS
See OCCIDENTAL FLASH PYROLYSIS PROCESS
OREGON/ELECTRIC POWER
Impacts of the western drought on regional electricity generation. Interim report, 2:56975 (PB-265 641)
ORGANIC CHLORINE COMPOUNDS
See also CHLORINATED ALIPHATIC HYDROCARBONS
CHLORINATED AROMATIC HYDROCARBONS
ORGANIC CHLORINE COMPOUNDS/ENVIRONMENTAL TRANSPORT
Chloro-organics in surface water sources for potable water, 2:57388 (CONF-770552-1)
ORGANIC CHLORINE COMPOUNDS/HEALTH HAZARDS
Chloro-organics in surface water sources for potable water, 2:57388 (CONF-770552-1)
ORGANIC COMPOUNDS
See also CHEMICAL FEEDSTOCKS
HETEROCYCLIC COMPOUNDS
HYDROCARBONS
KETONES
ORGANIC SULFUR COMPOUNDS
ORGANIC COMPOUNDS/CHEMICAL REACTION KINETICS
Reaction mechanisms of organic and inorganic ions in the gas phase, 2:57220
ORGANIC SOLVENTS/RECOVERY
Solvent Refined Coal (SRC) process. Quarterly technical progress report, July-September 1976, 2:55621 (FE-496-129)
ORGANIC SULFUR COMPOUNDS/DEGASSING
Organics used in microelectronics: a review of outgassing materials and effects, 2:57173 (SAND-76-5854C)
ORGANIC SULFUR COMPOUNDS/STRUCTURAL CHEMICAL ANALYSIS
High-sulfur shale oils. VII, 2:55849
ORGANIC WASTES/CARBONIZATION
Process and apparatus for the production of combustible gas (Patent; by carbonization and gasification of waste materials and other combustible materials), 2:55992
ORGANIC WASTES/GASIFICATION
Process and apparatus for the production of combustible gas (Patent; by carbonization and gasification of waste materials and other combustible materials), 2:55992
ORIFICES/SPECIFICATIONS
Optimized method for orificing LMFBR cores, 2:56530 (CONF-770611-6)
ORMAK DEVICES/THERMONUCLEAR REACTOR WALLS
Coatings application for fusion research, 2:57099
ORMAK DEVICES/X-RAY SPECTRA
Observation of tokamak plasmas with an array of pin diode detectors, 2:57636 (CONF-770434-6)
OSCILLATIONS/MATHEMATICAL MODELS
Mechanisms of chemical oscillators: conceptual bases, 2:57215
OSKARSHAMN-1 REACTOR
See OKG-1 REACTOR
OSMIUM 188 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
OSMIUM 189 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
OSMIUM 190/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
OSMIUM 192/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
OVERBURDEN/REMOVAL
Method and apparatus for strip mining (Patent; 13 claims), 2:55674
OXIDASES/BIOCHEMISTRY
Mechanisms of innate immunity: cytoplasmic granules of polymorphonuclear neutrophilic granulocytes, antimicrobial action, translocation, role, and fate in antimicrobial phagocytosis. Progress report, March 1976-June 30, 1977, 2:57413 (ORO-3628-11)
OXIDASES/CHEMICAL ANALYSIS
Mechanisms of innate immunity: cytoplasmic granules of polymorphonuclear neutrophilic granulocytes, antimicrobial action, translocation, role, and fate in antimicrobial phagocytosis. Progress report, March 1976-June 30, 1977, 2:57413 (ORO-3628-11)
OXIRANS
See EPOXIDES
OXONIUM IONS/CHEMICAL REACTION KINETICS
Reaction of e/sub aq/$^-$ + H_3O^+. Concentration effects of acid or salts, 2:57239
OXYGEN/ACTIVATION ANALYSIS
Determination of oxygen in reactive materials by 14-MeV neutron activation analysis, 2:57193
OXYGEN/CHEMICAL REACTION YIELD
Mechanism of the disproportionation of superoxide radicals (23°C; pH range 6.1-13.8), 2:57235
OXYGEN/COMBUSTION PROPERTIES
Investigation of a turbulent free-jet flame with chemical unbalance, 2:55976
OXYGEN/FLAMES
Investigation of a turbulent free-jet flame with chemical unbalance, 2:55976
OXYGEN/IGNITION
Explosion limits of hydrogen-oxygen mixture as a stochastic phenomenon, 2:55977
OXYGEN/ION-ATOM COLLISIONS
Dynamics of the reaction $D^+_3 + O(^3P)$ $OD^+ + D$, and the influence of the atomic quadrupole moment on the cross section at very low kinetic energies (0.002 to 27 eV), 2:57514
Long-range interactions of ions with atoms having partially filled p subshells (Born-Oppenheimer approximation), 2:57513
OXYGEN/NUCLEAR REACTION ANALYSIS
Low concentration oxygen depth profiling by the $^{16}O(d,\alpha)^{14}N$ reaction, 2:57190 (SAND-77-0424C)
Use of $^{12}C(d,p)^{13}C$ and $^{16}O(d,p)^{17}O$ reactions, 2:57189 (SAND-77-0366C)
OXYGEN/REDUCTION
Investigation of acid-resistant electrocatalysts for fuel cells, 2:56999 (N-77-16444)
OXYGEN 16/DISTRIBUTION
Low concentration oxygen depth profiling by the $^{16}O(d,\alpha)^{14}N$ reaction, 2:57190 (SAND-77-0424C)
Use of $^{12}C(d,p)^{13}C$ and $^{16}O(d,p)^{17}O$ reactions, 2:57189 (SAND-77-0366C)
OXYGEN EFFECT (RADIOBIOLOGY)
See OXYGEN
OZONE/ENERGY LEVELS
Theoretical studies of the atmospheric triatomic molecules H_2O, N_2O, NO_2, CO_2, O_3, and their ions, 2:57501 (ANL-77-3)
OZONE/EXCITED STATES
Geometries and energies of the excited states of O_3 from ab initio potential energy surfaces, 2:57503

P

PACEMAKERS
See CARDIAC PACEMAKERS
PACIFIC OCEAN
See also SAN FRANCISCO BAY
PACIFIC OCEAN/CONTAMINATION
Vertical distribution of ^{55}Fe in the ocean, 2:57399 (RLO-2231-T1-9)
PADE APPROXIMATION
Convergence of rows of the Pade table, 2:57829
PALLADIUM/ION-ATOM COLLISIONS
Study of K, L, and M inner-shell ionization by proton impact (Total cross sections, 150 to 500 Kev, Born approximation), 2:57539
PAPER CHROMATOGRAPHY
See CHROMATOGRAPHY
PAPER INDUSTRY/FIBERS
Fibers as renewable resources for industrial materials (Review and assessment), 2:56928 (PB-264561)
PAPER INDUSTRY/MATERIALS
Fibers as renewable resources for industrial materials (Review and assessment), 2:56928 (PB-264561)
PAPER INDUSTRY/RECYCLING
Impact of the Federal tax code on resource recovery. Final report (Effect of tax-subsidy elimination), 2:56929 (PB-264886)
PARABOLIC REFLECTORS
See also COMPOUND PARABOLIC CONCENTRATORS
PARABOLIC REFLECTORS/DESIGN
Investigations of a parabolocylindrical solar energy concentrator from mollified glass sheets, 2:56133
PARABOLIC REFLECTORS/FABRICATION
Investigations of a parabolocylindrical solar energy concentrator from mollified glass sheets, 2:56133
PARABOLIC REFLECTORS/OPTICAL PROPERTIES
Investigations of a parabolocylindrical solar energy concentrator from mollified glass sheets, 2:56133
PARAFFINS
See ALKANES
PARAMETRIC INSTABILITIES/LANDAU DAMPING
Unified formalism of lower hybrid parametric instabilities in plasmas, 2:57668

PARTICLE SIZE/STATISTICAL MODELS
Fundamental statistical methods in particle science, 2:57181 (LA-UR-77-1098)
PARTICLES (FUEL)
See FUEL PARTICLES
PARTITION CHROMATOGRAPHY
See CHROMATOGRAPHY
PATIENTS/DIAGNOSTIC TECHNIQUES
Argonne Bioanalytical Center: a resource for collaborative biomedical applications of stable isotopes, 2:57407 (CONF-761234-3)
PDP COMPUTERS/EQUIPMENT INTERFACES
Emmy/Unibus interface design specification. Technical note No. 109, 2:57815 (SU-326-P.39-19)
PDP COMPUTERS/FABRICATION
Using LSI processor bit-slices to build a PDP-11: a case study in microcomputer design (PDP-11 computer architecture built with bipolar microcomputer bit-slices), 2:57828 (UCRL-79581)
PEACH BOTTOM-1 REACTOR/FUEL ELEMENTS
Distribution of cesium and other fission products in Peach Bottom HTGR fuel elements, 2:56435
PEACH BOTTOM-1 REACTOR/PRIMARY COOLANT CIRCUITS
Study of radionuclides in the Peach Bottom HTGR primary circuit, 2:56436
PEANUTS/SOLAR DRYING
Solar energy applications in agriculture: potential, research needs, and adoption strategies, 2:56092 (PB-265105)
PEAT/COMBUSTION
Contamination of heating surfaces of boilers at Tyumen heat and power plant burning local peat, 2:56295
PEBBLE BED REACTORS/CONTROL ELEMENTS
Absorber rod to control a nuclear reactor with a charge of spherical fuel elements (Patent; Pebble Bed Reactors), 2:56732
PEBBLE BED REACTORS/FUEL SPHERES
Test or measuring sphere for nuclear reactors with spherical fuel elements (Patent), 2:56453
PEBBLE BED REACTORS/NEUTRON REFLECTORS
Graphite reflector in HTR with pebble bed and OTTO-fueling, 2:56445
PELLETS (FUEL)
See FUEL PELLETS
PERHYDROXYL RADICALS/OXIDATION
Mechanism of the disproportionation of superoxide radicals (23°C; pH range 6.1-13.8), 2:57235
PERHYDROXYL RADICALS/REDUCTION
Mechanism of the disproportionation of superoxide radicals (23°C; pH range 6.1-13.8), 2:57235
PERMAFROST/THAWING
Determination of the front of propagation of the permafrost thawing zone around producing wells, 2:55766
PERRYMAN-1 REACTOR/REACTOR SITES
Site suitability--site safety report, Volume I; geography, demography, nearby facilities, and meteorology, 2:56581 (DOCKET-50586-1)
PERRYMAN-2 REACTOR/REACTOR SITES
Site suitability--site safety report, Volume I; geography, demography, nearby facilities, and meteorology, 2:56581 (DOCKET-50586-1)
PERSONNEL/FINANCIAL DATA
FORMS: a generator of time-card forms, 2:57817 (UCID-30151)
PERSONNEL/INFORMATION
MANAGER: a generator of reports on the expenditure of scientific manpower, 2:57818 (UCID-30152)
PERSONNEL/RADIATION PROTECTION
Radiation safety (Criteria for radiation protection standards), 2:57428 (CONF-770615-2)
PETROCHEMICAL PLANTS/CHEMICAL FEEDSTOCKS
Natural gas: feedstock for ethylene plants, 2:55808
PETROCHEMICALS
See also CHEMICAL FEEDSTOCKS
PETROCHEMICALS/MANUFACTURING
Molecular-chain buildup in the FT synthesis, 2:55772
Petrochemical basic products from coal, 2:55627
Structural change in feedstocks supply for the petrochemicals industry, 2:55778
PETROCHEMICALS/MOLECULAR STRUCTURE
Molecular-chain buildup in the FT synthesis, 2:55772
PETROCHEMICALS/PRODUCTION
Coal catalyst, 2:55629 (AD-D-003508)
PETROLEUM
See also OIL WELLS
SHALE OIL
PETROLEUM/ADDITIVES
Possibility of selecting the most economical pour point depressant from the user's standpoint, 2:55770
PETROLEUM/BIOLOGICAL EFFECTS
Chemical composition and effects of water extracts of petroleum on eggs of the sand dollar Melitta quinquiesperforata, 2:57448
PETROLEUM/CHARGES
OPEC and the monopoly price of world oil (World Oil Project). Working paper, 2:56970 (PB-265015)
PETROLEUM/CHROMATOGRAPHY
Application of gel permeation chromatography to the examination of crude oil, 2:55801
PETROLEUM/ECONOMIC ELASTICITY
Project Independence evaluation system (PIES) documentation. Volume VI. Methodology for improving the price sensitivity of the PIES oil and gas supply curves, 2:56950 (PB-264069)
PETROLEUM/MARKET
OPEC and the monopoly price of world oil (World Oil Project). Working paper, 2:56970 (PB-265015)
PETROLEUM/PHYSICAL PROPERTIES
Possibility of selecting the most economical pour point depressant from the user's standpoint, 2:55770
PETROLEUM/POUR POINT
Possibility of selecting the most economical pour point depressant from the user's standpoint, 2:55770
PETROLEUM/PRODUCTION
Project Independence evaluation system (PIES) documentation. Volume VII. Methodology for developing more complex investment and production profiles in the FEA oil and gas supply model, 2:56951 (PB-264649)
PETROLEUM/RECYCLING
Oil conservation and reclamation, 2:55789
PETROLEUM/RESOURCE CONSERVATION
Oil conservation and reclamation, 2:55789
PETROLEUM/TRANSPORT
Cathodic protection of pipes and pipelines offshore, 2:55797
North Sea offshore loading, what is the problem, 2:55799
Planning and laying of Cormorant pipeline, 2:55796
Possibility of selecting the most economical pour point depressant from the user's standpoint, 2:55770
PETROLEUM/UNDERGROUND STORAGE
Technical innovations in solution mining and their application in the federal Etzel cavern project, 2:55803
PETROLEUM/VISCOSITY
Possibility of selecting the most economical pour point depressant from the user's standpoint, 2:55770
PETROLEUM DEPOSITS
See also OIL FIELDS
PETROLEUM DEPOSITS/CLASSIFICATION
Classification of hydrocarbon pools, 2:55802
PETROLEUM DEPOSITS/DATA COMPILATION
Example of statistical data available for petroleum exploration: the STATSID file, 2:55745
PETROLEUM DEPOSITS/DISTRIBUTION
Oil and gas geological zoning of the Siberian Platform, 2:55741
PETROLEUM DEPOSITS/ELECTRICAL SURVEYS
Drilling/exploration activities, 2:57464
PETROLEUM DEPOSITS/EVALUATION
Evaluation of oil and gas potential in Maykopian sedimentary rocks in crimeia, west pre-caucausus and offshore areas of Karkinit Bay and Azov Sea, 2:55754
PETROLEUM DEPOSITS/EXPLORATION
Calculation of oil and solution and free gas initially in place and their recovery during exploration, 2:55749
Data base for analyzing results of oil and gas exploration, 2:55748
Drilling/exploration activities, 2:57464
Example of statistical data available for petroleum exploration: the STATSID file, 2:55745
Formation of oil and gas pools and technique for their exploration in southern regions of Siberian platform, 2:55753
Geothermal conditions of subsalt rocks of the eastern part of pre-caspian depression and their oil and gas potential, 2:55751
Middle--upper Devonian clastic wedge of the Franklinian geosyncline, 2:55750
Paleozoic carbonate formations in the south-east of Russian Platform and their oil and gas potential, 2:55752
Rapid method for source rock characterization and for determination of their petroleum potential and degree of evolution, 2:55746
PETROLEUM DEPOSITS/GEOLOGIC STRUCTURES
Drilling/exploration activities, 2:57464
PETROLEUM DEPOSITS/GEOLOGY
Data base for analyzing results of oil and gas exploration, 2:55748
PETROLEUM DEPOSITS/OIL YIELDS
Rapid method for source rock characterization and for determination of their petroleum potential and degree of evolution, 2:55746
PETROLEUM DEPOSITS/PETROGENESIS
Cyclic character of the processes of oil and gas generation, petroliferous provinces, basins and regions, 2:55742
PETROLEUM DEPOSITS/PROSPECTING
Direction of exploration and possibilities of hydrocarbon pool discoveries in the Volyno-Podolian area, 2:55747

PETROLEUM DEPOSITS/SPATIAL DISTRIBUTION
Cyclic character of the processes of oil and gas generation, petroliferous provinces, basins and regions, 2:55742
PETROLEUM DISTILLATES/CHROMATOGRAPHY
Developing empirical correlations from basic GPC data and deriving of fundamental GPC parameters for a given system, 2:57206 (BERC/RI-76/14)
PETROLEUM DISTILLATES/DENSITY
Developing empirical correlations from basic GPC data and deriving of fundamental GPC parameters for a given system, 2:57206 (BERC/RI-76/14)
PETROLEUM INDUSTRY
See also MINERAL INDUSTRY
Petropolitics and the Atlantic Alliance (Short- and long-term effects of petroleum crisis), 2:56969 (AD-A-037807)
PETROLEUM INDUSTRY/INVESTMENT
Dynamics of petroleum industry investment in the North Sea. (World Oil Project), 2:56971 (PB-265093)
PETROLEUM INDUSTRY/MANAGEMENT
Business systems for hydrocarbon resources: their credibility in retrospect and in prospect, 2:55816
Metricating the crude oil and natural gas industry, 2:55703
PETROLEUM INDUSTRY/PROFITS
Impact of mandatory petroleum allocation, price, and other regulations on the profitability, competitive viability, and ease of entry of independent refiners and small refiners, 2:56972 (PB-265143)
PETROLEUM INDUSTRY/REGULATIONS
Impact of mandatory petroleum allocation, price, and other regulations on the profitability, competitive viability, and ease of entry of independent refiners and small refiners, 2:56972 (PB-265143)
PETROLEUM PRODUCTS
See also GASOLINE
KEROSENE
LUBRICATING OILS
PETROLEUM PRODUCTS/CHARGES
Monthly petroleum product price report, 2:55784 (PB-264142)
Monthly petroleum product price report, 2:55786 (PB-264460)
PETROLEUM PRODUCTS/MARKET
Petroleum market shares: report on sales of refined petroleum products, October 1976, 2:55783 (PB-263966)
Petroleum market shares. Report on sales of refined petroleum products. Monthly report, 2:55785 (PB-264143)
PETROLEUM REFINERIES/CHEMICAL REACTORS
Material manufacturing and fabrication of ultra-large size hydrodesulphurization reactors, 2:57263
PETROLEUM REFINERIES/EQUIPMENT
Carburization of centrifugally cast tubes in the petrochemical industry and explanation of this behavior based on laboratory tests on Cr-Ni steels and alloys at 800 and 1150°C, 2:57135
PETROLEUM REFINERIES/FLUE GAS
Recovery of flare gases: a technical process for economical use of flare gases, 2:55769
PETROLEUM REFINERIES/PRESSURE VESSELS
Material manufacturing and fabrication of ultra-large size hydrodesulphurization reactors, 2:57263
PETROLEUM RESIDUES
See HEAVY OILS
PFR REACTOR/COOLANT CLEANUP SYSTEMS
Impurity deposition in PFR plugging meters and cold traps, 2:56480 (CONF-760503-P1)
PFR REACTOR/FUEL ASSEMBLIES
Actinide fission rate measurements in Zebra, 2:56474 (AEEW-R-1090)
PFR REACTOR/PERFORMANCE
Operation of PFR and influence upon the design of CFR I, 2:56541 (TRG-Report-2819(D))
PFR REACTOR/PRIMARY COOLANT CIRCUITS
Activity deposition in DFR primary cold traps, 2:56482 (CONF-760503-P1)
PFR REACTOR/REACTOR OPERATION
Britain's prototype fast reactor: key to the commercial FBR systems, 2:56552
PFR REACTOR/SUPERHEATERS
Modelling and analysis of the PFR superheater toroidal header, 2:56555
PHAGES
See BACTERIOPHAGES
PHASE TRANSFORMATIONS/PRESSURE DEPENDENCE
Some applications of high pressure studies of phase transitions in solids, 2:57175 (SAND-77-0104C)
PHENIX REACTOR/COOLANT CLEANUP SYSTEMS
Evolution of sodium purification: RAPSODIE, PHENIX, SUPER-PHENIX, 2:56484 (CONF-760503-P1)
PHENIX REACTOR/REACTOR OPERATION
Some aspects of sodium technology issued from the operating experience of RAPSODIE and PHENIX, 2:56478 (CONF-760503-P1)
PHENIX REACTOR/STEAM GENERATORS
Tube tightness survey during Phenix steam generator operation, 2:56483 (CONF-760503-P1)
PHENOLS/CHEMICAL PREPARATION
Physical and chemical behavior of liquefied coal in solids separation. Quarterly report, January-March 1977 (9 refs), 2:55613 (FE-2550-2)
PHENYLMETHYLETHER
See ANISOLE
PHIPPS BEND-1 REACTOR/REACTOR SAFETY
Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I-VI, 2:56787 (ORNL/NUREG/NSIC-136)
PHIPPS BEND-2 REACTOR/REACTOR SAFETY
Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I-VI, 2:56787 (ORNL/NUREG/NSIC-136)
PHOSPHATES/QUANTITATIVE CHEMICAL ANALYSIS
New portable centrifugal fast analyzer with expanded versatility, 2:57201 (CONF-770332-1)
PHOSPHIDES/CURIE POINT
Ferromagnetic and antiferromagnetic coupling in amorphous (Ni/sub 100-c/Mn/sub c/)$_{78}P_{14}B_8$ (C=0.7 to 20 at.% 1.7 to 270°K), 2:57127 (CALT-822-91)
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
PHOSPHIDES/ELECTRIC CONDUCTIVITY
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
PHOSPHIDES/MAGNETIZATION
Ferromagnetic and antiferromagnetic coupling in amorphous (Ni/sub 100-c/Mn/sub c/)$_{78}P_{14}B_8$ (C=0.7 to 20 at.% 1.7 to 270°K), 2:57127 (CALT-822-91)
Magnetic regimes in amorphous Ni-Fe-P-B alloys (1.7 to 300°K), 2:57126 (CALT-822-88)
PHOSPHINES/CRYSTAL STRUCTURE
Novel co-ordination of sulphur dioxide. The crystal and molecular structure of nitrosyl(sulfur dioxide)bis(triphenylphosphine)rhodium, 2:57233
PHOSPHINES/SYNTHESIS
Novel co-ordination of sulphur dioxide. The crystal and molecular structure of nitrosyl(sulfur dioxide)bis(triphenylphosphine)rhodium, 2:57233
PHOSPHORIC ACID ESTERS/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
PHOSPHORUS/SEPARATION PROCESSES
Process design manual for phosphorus removal, 2:57207 (EPA-625/1-76-001a)
PHOTOCHEMICAL OXIDANTS/AIR POLLUTION ABATEMENT
Oxidant control strategies. Part I. Urban oxidant control strategy derived from existing smog chamber data, 2:57365
PHOTODETECTORS/PERFORMANCE
Comparison of a thermopile broadband detector and a photon detector for the measurement of solar radiation. Part I. Analysis of simultaneous data. Part II. Cosine response functions, 2:56022 (PB-265282)
PHOTODISINTEGRATION
See PHOTONUCLEAR REACTIONS
PHOTON COLLISIONS
See also PHOTON-MOLECULE COLLISIONS
PHOTON COLLISIONS/IONIZATION
Multiphoton processes with polarized light (Review, radiation perturbation theory), 2:57545
PHOTON-DEUTERON INTERACTIONS/KNOCK-OUT REACTIONS
Contributions to the theory of isobar knockout from a deuteron, 2:57585
PHOTON-MOLECULE COLLISIONS/IONIZATION
Laser photodissociation of hydrogen molecule ions with fragment kinetic energy analysis, 2:57506
PHOTON-PROTON INTERACTIONS/DIFFERENTIAL CROSS SECTIONS
Photoproduction of neutral pions from hydrogen at 320 MeV, 2:57562
PHOTONUCLEAR REACTIONS/CROSS SECTIONS
Method of obtaining photonuclear cross sections in the near-threshold region, 2:57611
PHOTOVOLTAIC CELLS/RESEARCH PROGRAMS
Status of the ERDA photovoltaic materials and device studies, 2:56066
PHOTOVOLTAIC POWER PLANTS
See also SOLAR CELL ARRAYS
PHOTOVOLTAIC POWER PLANTS/ECONOMICS
Photovoltaic system performance, applications and prospects for economic viability in central utility networks, 2:56078

PHOTOVOLTAIC POWER PLANTS/PERFORMANCE
Photovoltaic system performance, applications and prospects for economic viability in central utility networks, 2:56078
PHTHALIC ACID ESTERS/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
PHTHALOCYANINES/CATALYTIC EFFECTS
Investigation of acid-resistant electrocatalysts for fuel cells, 2:56999 (N-77-16444)
PHWR TYPE REACTORS
See also PICKERING-3 REACTOR
PICKERING-4 REACTOR
PHWR TYPE REACTORS/CALANDRIAS
Finite element analysis of reactor support diaphragm for elastic instability, 2:56465
PHYSICAL PROTECTION DEVICES
See also SECURITY SEALS
PHYSICAL PROTECTION DEVICES/DESIGN
Surveillance and containment instrumentation international safeguards (Surveillance camera, fuel bundle counter, and reef-monitoring seal), 2:55962 (SAND-77-0980C)
PHYSICAL PROTECTION DEVICES/INFORMATION SYSTEMS
Barrier Data Base user's guide, 2:57831 (SAND-76-0521)
PICKERING-3 REACTOR/PRESSURE TUBES
Delayed hydrogen cracking of zirconium alloy pressure tubes, 2:56470
PICKERING-4 REACTOR/PRESSURE TUBES
Delayed hydrogen cracking of zirconium alloy pressure tubes, 2:56470
PINS (FUEL)
See FUEL PINS
PION MINUS-NEUTRON INTERACTIONS/CORRELATIONS
Two-particle correlations of charged particles and γ rays in π^- n interactions at momentum 40 GeV/c, 2:57570
PION MINUS-NEUTRON INTERACTIONS/LIMITING FRAGMENTATION
Early scaling and exotic channels in πN interactions in the fragmentation regions, 2:57582
PION MINUS-NEUTRON INTERACTIONS/SCALING LAWS
Early scaling and exotic channels in πN interactions in the fragmentation regions, 2:57582
PION MINUS-PROTON INTERACTIONS/CROSS SECTIONS
Investigation of rho°- and ω-meson production in π^- p interactions at 40 GeV/c, 2:57571
PION MINUS-PROTON INTERACTIONS/ELASTIC SCATTERING
Measurement of the π^+ p and π^- p polarization parameters at 100 GeV/c, 2:57567
PION MINUS-PROTON INTERACTIONS/LIMITING FRAGMENTATION
Early scaling and exotic channels in πN interactions in the fragmentation regions, 2:57582
PION MINUS-PROTON INTERACTIONS/POLARIZATION
Measurement of the π^+ p and π^- p polarization parameters at 100 GeV/c, 2:57567
PION MINUS-PROTON INTERACTIONS/SCALING LAWS
Early scaling and exotic channels in πN interactions in the fragmentation regions, 2:57582
PION PLUS REACTIONS/KNOCK-OUT REACTIONS
Emission of protons in π^+ + Xe interactions at 2.34 GeV/c and Fermi motion of neutrons inside the nucleus, 2:57598
PION PLUS-PROTON INTERACTIONS/DIFFERENTIAL CROSS SECTIONS
Comparison of the line-reversed channels p-barp $\pi^-\pi^+$ and π^+ p $p\pi^+$ at 6 GeV/c, 2:57566
PION PLUS-PROTON INTERACTIONS/ELASTIC SCATTERING
Elastic π^+ p, K^+ p, and pp scattering in the region of Coulomb-nuclear interference at momenta 42.5 and 52.2 GeV/c, 2:57569
Measurement of the π^+ p and π^- p polarization parameters at 100 GeV/c, 2:57567
PION PLUS-PROTON INTERACTIONS/POLARIZATION
Measurement of the π^+ p and π^- p polarization parameters at 100 GeV/c, 2:57567
PION PLUS-PROTON INTERACTIONS/TOTAL CROSS SECTIONS
Elastic π^+ p, K^+ p, and pp scattering in the region of Coulomb-nuclear interference at momenta 42.5 and 52.2 GeV/c, 2:57569
PION-DEUTERON INTERACTIONS/KNOCK-OUT REACTIONS
Contributions to the theory of isobar knockout from a deuteron, 2:57585
PION-DEUTERON INTERACTIONS/MULTIPLE SCATTERING
Double scattering in deuterium as a probe of hadron structure, 2:57583
PION-NUCLEON INTERACTIONS/ELASTIC SCATTERING
Elastic πN scattering in a dual model with the correct spectrum of baryon resonances, 2:57581
PION-PION INTERACTIONS/ELASTIC SCATTERING
Unified description of the processes $\pi\pi$ $\pi\pi$ and $\pi\pi$ KK-bar, 2:57580
PION-PION INTERACTIONS/PAIR PRODUCTION
Unified description of the processes $\pi\pi$ $\pi\pi$ and $\pi\pi$ KK-bar, 2:57580
PIONS
See also PIONS NEUTRAL
PIONS/PARTICLE PRODUCTION
Production of ultrafast pions in collisions of relativistic deuterons with protons and nuclei, 2:57584
PIONS/STRUCTURE FUNCTIONS
Deep-inelastic scattering of leptons by virtual particles, 2:57574
PIONS NEUTRAL/PHOTOPRODUCTION
Photoproduction of neutral pions from hydrogen at 320 MeV, 2:57562
PIPE FITTINGS/DESIGN
Square through tube (Patent), 2:56699
PIPE FITTINGS/FATIGUE
Creep-fatigue test of an elbow subjected to cyclic in-plane moment loading (LMFBR; SS-304), 2:56558
PIPE JOINTS/ELECTROSLAG WELDING
New and advanced technological process of manufacture of connecting pipes on frames of nuclear power plants by electroslag welding, 2:57097
PIPE JOINTS/FATIGUE
Studies on the fatigue of branched connections related to the shakedown pressure, 2:57258
PIPE JOINTS/WELDED JOINTS
Raising the reliability of boiler units by improving the quality of welding of the heating surfaces, 2:56273
PIPELINE QUALITY GAS
See HIGH BTU GAS
PIPELINES
See also NATURAL GAS DISTRIBUTION SYSTEMS
SLURRY PIPELINES
PIPELINES/CATHODIC PROTECTION
Cathodic protection of pipes and pipelines offshore, 2:55797
Computing methods for designing cathodic protection systems for elongate structures, 2:55798
PIPELINES/CONSTRUCTION
Planning and laying of Cormorant pipeline, 2:55796
PIPELINES/CONTROL SYSTEMS
Modern mobile radio system, 2:55826
PIPELINES/GOVERNMENT POLICIES
Local regulation of pipeline sitings and the doctrines of Federal preemption and supremacy, 2:56958 (PB-265447)
PIPELINES/HYDRAULICS
Some problems of hydraulic calculation of gas pipelines transporting gas and air mixture, 2:55824
PIPELINES/LEAK DETECTORS
IGT experience in leak detection methodology and systems, 2:55818 (NP-22364)
PIPELINES/PLANNING
Planning and laying of Cormorant pipeline, 2:55796
PIPELINES/SIMULATION
Calculation of nonstationary gas network using the Ganesi program system, 2:55821
Nonstationary gas network calculation: simulation and comparative measurement, 2:55822
PIPELINES/SITE SELECTION
Local regulation of pipeline sitings and the doctrines of Federal preemption and supremacy, 2:56958 (PB-265447)
PIPELINES/TRANSPORT
Some problems of hydraulic calculation of gas pipelines transporting gas and air mixture, 2:55824
PIPELINES/VORTEX FLOW
Measuring fluid flow by vortex shedding, 2:55825
PIPES/BENDING
Mastering the process of cold bending of pipes for a small radius in Soviet boilermaking, 2:57098
PIPES/CORROSION
Importance of experience in scale removal, 2:56258
PIPES/CRACKS
Fracture in straight pipes under large deflection conditions. II. Pipe pressures, 2:56374
PIPES/CREEP
Permissible value of compensation stresses in piping systems of power plants, operating in creep conditions, 2:56289
PIPES/DEFORMATION
Dynamic analysis of hydraulic pressure wave propagation in a plastically deforming pipe, 2:56840
Fracture in straight pipes under large deflection conditions. I. Structural deformations, 2:56661

PIPES/FAILURES
Characteristics of pipe system failures in light-water reactors, 2:56861
PIPES/FRACTURE PROPERTIES
Surface flaw in a pressurised and thermally-shocked hollow cylinder, 2:56658
PIPES/FRACTURES
Fracture in straight pipes under large deflection conditions. II. Pipe pressures, 2:56374
PIPES/MECHANICAL PROPERTIES
Effect of stress concentrators on the strength of pipes of boiler heating surfaces made of 12cr1mov and Cr18Ni12Ti steel grades, 2:57124
Working capacity and reliability of pipes made of steel 12Cr1MoV after long periods of operations, 2:57123
PIPES/SAFETY STANDARDS
Permissible value of compensation stresses in piping systems of power plants, operating in creep conditions, 2:56289
PIPES/SERVICE LIFE
Ways to solve the problem of extending the service life of existing and projected steam pipelines beyond 100,000 hr, 2:57122
Working capacity and reliability of pipes made of steel 12Cr1MoV after long periods of operations, 2:57123
PIPES/SPECIFICATIONS
Contributions of the ORNL piping program to nuclear piping design codes and standards, 2:56662
PIPES/STRESS ANALYSIS
Permissible value of compensation stresses in piping systems of power plants, operating in creep conditions, 2:56289
Surface flaw in a pressurised and thermally-shocked hollow cylinder, 2:56658
PIPES/TESTING
Rubber pipe for hydraulic stowing, 2:55718
PIPES/WELDED JOINTS
Fatigue strength of electron beam welded stainless steel pipes, 2:57259
PISTONS/DESIGN
Development of promising designs of pistons for boosted modifications of diesels of the chn21/21 type, 2:57054
Investigation of the three-dimensional thermal and stress strained state of a one-piece piston of the chn 21/21 diesel engine, using the finite element method, 2:57324
PISTONS/RINGS
Investigation of the effect of the design and number of piston rings on lubricant burn-up waste, 2:57057
PISTONS/THERMAL STRESSES
Investigation of the three-dimensional thermal and stress strained state of a one-piece piston of the chn 21/21 diesel engine, using the finite element method, 2:57324
PISTONS/WEAR
Evaluation of the limit state of a cylinder and piston group of diesel engines, 2:57020
PLANETARY ATMOSPHERES/ELECTRON DENSITY
Electron currents measured in the optical shadow of Venus by the "Venera-9" and "Venera-10" satellites; the basic source of ionization in the nightside ionosphere of Venus, 2:57489
PLANTS
See also AQUATIC ORGANISMS
BIOMASS
PLANTS/RADIATION MONITORING
Dose assessment at Bikini Atoll (^{90}Sr, ^{137}Cs), 2:57437 (UCRL-51879(Pt.5))
PLANTS (INDUSTRIAL)
See INDUSTRIAL PLANTS
PLANTS (POWER)
See POWER PLANTS
PLASMA
See also BEAM-PLASMA SYSTEMS
HIGH-BETA PLASMA
HOMOGENEOUS PLASMA
HOT PLASMA
INHOMOGENEOUS PLASMA
LASER-PRODUCED PLASMA
Ukrainian Physics Journal (Cover-to-cover translation into English of Ukrainskii Fizicheskii Zhurnal, no. 9 (September 1971)), 2:57089 (AEC-tr-7297/9)
PLASMA/ATOM-ATOM COLLISIONS
Atomic physics in the controlled thermonuclear research program, 2:57646
PLASMA/BIBLIOGRAPHIES
Technology index for plasmaphysics research and fusion reactors. Volume 11, No. 6, 1977. Bibliography, author index, subject index, appendix, 2:57626
Technology index for plasmaphysics research and fusion reactors. Volume 11, No. 5, 1977. Bibliography, author index, subject index, appendix, 2:57627
PLASMA/CHARGE EXCHANGE
Asymptotically exact theory of electron exchange in distant collisions, 2:57650
PLASMA/ELECTROMAGNETIC RADIATION
An experimental and theoretical study of the propagation of high amplitude pulses in a bounded magneto-plasma. Interim report, 2:57674 (AD-A-037663)
PLASMA/ENERGY LOSSES
Plasma impurity radiation from iron and silicon, 2:57647
PLASMA/IMPURITIES
Plasma impurity radiation from iron and silicon, 2:57647
PLASMA/ION-ATOM COLLISIONS
Atomic physics in the controlled thermonuclear research program, 2:57646
PLASMA/LASER RADIATION
Laser fusion implosion and target interaction physics, 2:57771 (UCRL-79540)
Theoretical interpretation of angle- and polarization-dependent laser light absorption measurements, 2:57772 (UCRL-79628)
PLASMA/MEETINGS
Plasma physics and controlled nuclear fusion research, 1976. Nuclear fusion, supplement 1977. Volume I, 2:57687 (STI/PUB-439(Vol.1))
Plasma physics and controlled nuclear fusion research, 1976. Nuclear fusion, supplement 1977. Volume II, 2:57688 (STI/PUB-439(Vol.2))
Plasma physics and controlled nuclear fusion research, 1976. Nuclear fusion, supplement 1977. Volume III, 2:57689 (STI/PUB-439(Vol.3))
PLASMA/ROTATION
Plasma rotations induced by 3.5-MeV alpha-particle losses, 2:57645
PLASMA CONFINEMENT/TOROIDAL CONFIGURATION
Radial boundary layers in diffusing toroidal equilibria, 2:57629
PLASMA DIAGNOSTICS/ELECTROSTATIC PROBES
Axial density and temperature variations in a magnetically confined arc, 2:57639
PLASMA DIAGNOSTICS/HYPERFINE STRUCTURE
Simultaneous determination of the temperature and density of metal atoms in a plasma, 2:57640
PLASMA DIAGNOSTICS/LASER RADIATION
ORNL plasma diagnostic research, 2:57635 (CONF-770434-5)
Raman scattering: a possibility of calibrating laser scattering devices, 2:57641
PLASMA DIAGNOSTICS/NEUTRAL ATOM BEAM INJECTION
Local diagnostics of impurity ions in a hot plasma, 2:57637
PLASMA DIAGNOSTICS/RAMAN EFFECT
Raman scattering: a possibility of calibrating laser scattering devices, 2:57641
PLASMA DIAGNOSTICS/STARK EFFECT
Stark effect in three-dimensional stochastic electric fields and a static magnetic field of a helium plasma, 2:57638
PLASMA DIAGNOSTICS/X-RAY EMISSION ANALYSIS
Ultrafast x-ray diagnostics for laser fusion experiments, 2:57644
PLASMA DIAGNOSTICS/X-RAY SPECTRA
Observation of tokamak plasmas with an array of pin diode detectors, 2:57636 (CONF-770434-6)
PLASMA DIAGNOSTICS/X-RAY SPECTROMETERS
MOS solid-state detector arrays for x-ray imaging, 2:57336 (UCRL-79376)
PLASMA FOCUS DEVICES/OPERATION
Operation of a plasma-focus device with D_2 and He^3, 2:57653
PLASMA FOCUS DEVICES/PINCH EFFECT
Formation of plasma focus in erosion-type plasma accelerators. II, 2:57659
PLASMA FOCUS DEVICES/PLASMA DIAGNOSTICS
Operation of a plasma-focus device with D_2 and He^3, 2:57653
PLASMA GUNS
Experimental investigation of a discharge in a high-current coaxial plasma source, 2:57658
PLASMA GUNS/PLASMA PRODUCTION
High-current plasma accelerator for the investigation of plasma wall interaction, 2:57654
PLASMA INSTABILITY
See also CONVECTIVE INSTABILITIES
DECAY INSTABILITY
PARAMETRIC INSTABILITIES
PLASMA MACROINSTABILITIES
PLASMA MICROINSTABILITIES
PLASMA INSTABILITY/COMPUTER CODES
ELIPTI code: Part I (For solving nonlinear elliptic problems over 2D regions of arbitrary shape), 2:57826 (UCRL-79328(Pt.1))
PLASMA MACROINSTABILITIES
See also KINK INSTABILITY
PLASMA MACROINSTABILITIES/COMPUTER CALCULATIONS
Comparative numerical studies of ideal magnetohydrodynamic instabilities, 2:57663 (PPPL-1349)

PLASMA MACROINSTABILITIES/INSTABILITY GROWTH RATES
Reduction of the growth rate of the m = 1 resistive magnetohydrodynamic mode by finite gyroradius effects, 2:57662 (ORNL/TM-5968)
PLASMA MACROINSTABILITIES/NUMERICAL SOLUTION
Elements of magnetohydrodynamic stability theory, 2:57660 (COO-3077-137)
PLASMA MACROINSTABILITIES/STABILIZATION
Feedback stabilization experiments using l = 2 equilibrium windings in Scyllac, 2:57661 (LA-UR-77-1142)
PLASMA MICROINSTABILITIES
See also CYCLOTRON INSTABILITY
DRIFT INSTABILITY
LOSS CONE INSTABILITY
PLASMA MICROINSTABILITIES/MODULATION
Nonlinear propagation of ion-cyclotron modes, 2:57666
PLASMA MICROINSTABILITIES/REVIEWS
Microinstability theory in tokamaks: a review, 2:57664 (PPPL-1354)
PLASMA MICROINSTABILITIES/SOLITONS
Nonlinear propagation of ion-cyclotron modes, 2:57666
PLASMA PRODUCTION/ELECTRIC DISCHARGES
Experimental investigation of a discharge in a high-current coaxial plasma source, 2:57658
Method and apparatus for generating and utilizing a compound plasma configuration (Patent), 2:57655
PLASMA PRODUCTION/ELECTRON BEAMS
Radiation patterns from electron beam fusion targets, 2:57783
PLASMA PRODUCTION/NEUTRON EMISSION
Neutron and energetic ion production in exploded polyethylene fibers, 2:57652
PLASMA WAVES
See also ELECTRON PLASMA WAVES
ION ACOUSTIC WAVES
PLASMA WAVES/AMPLITUDES
Wave-breaking amplitudes in warm, inhomogeneous plasmas, 2:57676 (UCRL-79604)
PLASMA WAVES/HARMONICS
Trapped particles and harmonic generation, 2:57675 (UCRL-13727)
PLASMA WAVES/NONLINEAR PROBLEMS
Ponderomotive force and linear susceptibility in Vlasov plasma, 2:57684
PLASMA WAVES/PLASMA DRIFT
Wave analysis of the tokamak drift mode, 2:57682
PLASMA WAVES/WAVE PROPAGATION
Nonlinear distortion of propagation cones of lower hybrid wave in an inhomogeneous plasma, 2:57679
Propagation of nonlinear waves along a magneto-plasma column, 2:57678
PLASTICS
See also POLYETHYLENES
POLYURETHANES
THERMOPLASTICS
PLASTICS/WEATHERING
Real time outdoor exposure testing of solar cell modules and component materials, 2:56042 (ERDA/NASA/1022-77/10)
PLATES
(Thicker than SHEETS or FOILS.)
PLATES/FRACTURE PROPERTIES
Surface flaw in a pressurised and thermally-shocked hollow cylinder, 2:56658
PLATES/STRESS ANALYSIS
Surface flaw in a pressurised and thermally-shocked hollow cylinder, 2:56658
PLATES (FUEL)
See FUEL PLATES
PLATFORM MOUNTED NUCLEAR PLANT
See OFFSHORE NUCLEAR POWER PLANTS
PLATINUM/CRYSTALLOGRAPHY
Surface crystallography of clean platinum single crystals and adsorbed hydrocarbon overlayers studied by low energy electron diffraction, 2:57211 (LBL-6221)
PLATINUM 192/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
PLATINUM 194 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
PLATINUM 195 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
PLATINUM 196 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
PLT DEVICES
(Princeton Large Torus.)
PLT DEVICES/ELECTRON CYCLOTRON-RESONANCE
Electron cyclotron emission from the Princeton Large Tokamak, 2:57685
PLUMES/DIFFUSION
Lidar observations of plume diffusion at Rancho Seco Generating Station, 2:57364
Use of sulfur hexafluoride tracer techniques for near-stack dispersion studies, 2:57371
PLUMES/ENVIRONMENTAL TRANSPORT
Chalk Point Cooling Tower Project. Volume 1. Phase IV, comprehensive field program description. Environmental Systems Corporation's comprehensive project final report, October 1, 1975-June 30, 1976 (Fossil-fuel power plant), 2:57362 (PPSP-CPCTP-12(Vol.1))
PLUMES/MATHEMATICAL MODELS
Analysis of buoyant surface jets, 2:57386
The chemistry, dispersion, and transport of air pollutants emitted from fossil fuel power plants in California: data analysis and emission impact model. Final report, 2:57357 (PB-264822)
PLUTONIUM/CHEMICAL ANALYSIS
Coulometer operator's manual, 2:57194 (LA-6883-MS)
PLUTONIUM/CHEMICAL REACTION KINETICS
Reaction between plutonium and deuterium. Part II. Rate measurements by weight changes, 2:57241 (LA-6681-MS)
PLUTONIUM/GAMMA SPECTROSCOPY
Progress report for the Division of Safeguards and Security: July-December 1976, 2:55955 (MLM-2429)
PLUTONIUM/HAZARDS
Is plutonium really necessary, 2:55954 (CONF-7605150-1)
PLUTONIUM/MATERIALS HANDLING
Role of the engineer in protecting personnel and the environment in the nuclear industry, 2:57273 (MLM-2438(OP))
PLUTONIUM/SEPARATION PROCESSES
Process for separating ceramics of uranium and plutonium from zirconium by hydriding and mixtures thereof (Patent), 2:55884
PLUTONIUM 236/NUCLEAR PROPERTIES
PURSE: plutonium radiation source code, 2:55868 (PNCT-841-75-37)
PLUTONIUM 238/NUCLEAR PROPERTIES
PURSE: plutonium radiation source code, 2:55868 (PNCT-841-75-37)
PLUTONIUM 238/RADIOISOTOPE HEAT SOURCES
^{238}Pu fuel form processes. Savannah River Laboratory monthly report, June 1977, 2:55974 (DPST-77-128-6)
PLUTONIUM 239/CRITICALITY
Criticality safety in processing and handling fissile materials. Criticality data for plutonium 239-dioxide light-water-mixtures, 2:55877
Criticality safety in processing and handling fissile materials. Criticality data for plutonium 239 nitrate light-water-mixtures, 2:55878
PLUTONIUM 239/FISSION YIELD
Actinide fission rate measurements in Zebra, 2:56474 (AEEW-R-1090)
PLUTONIUM 239/HALF-LIFE
Progress report for the Division of Safeguards and Security: July-December 1976, 2:55955 (MLM-2429)
PLUTONIUM 239/NUCLEAR PROPERTIES
PURSE: plutonium radiation source code, 2:55868 (PNCT-841-75-37)
PLUTONIUM 240/FISSION YIELD
Actinide fission rate measurements in Zebra, 2:56474 (AEEW-R-1090)
PLUTONIUM 240/NUCLEAR PROPERTIES
PURSE: plutonium radiation source code, 2:55868 (PNCT-841-75-37)
PLUTONIUM 240 TARGET/NEUTRON REACTIONS
Neutron capture cross section of ^{240}Pu (200 eV to 350 keV), 2:57603
PLUTONIUM 241/FISSION YIELD
Actinide fission rate measurements in Zebra, 2:56474 (AEEW-R-1090)
PLUTONIUM 241/NUCLEAR PROPERTIES
PURSE: plutonium radiation source code, 2:55868 (PNCT-841-75-37)
PLUTONIUM 241 TARGET/NEUTRON REACTIONS
Measurement of the fission cross section of ^{241}Pu from 8 eV to 70 keV, 2:57605
PLUTONIUM 242/FISSION YIELD
Actinide fission rate measurements in Zebra, 2:56474 (AEEW-R-1090)
PLUTONIUM 242/NUCLEAR PROPERTIES
PURSE: plutonium radiation source code, 2:55868 (PNCT-841-75-37)
PLUTONIUM 244 TARGET/NEUTRON REACTIONS
Cross section for fission of ^{244}Pu by fast neutrons, 2:57608
PLUTONIUM 245/FISSION BARRIER
Cross section for fission of ^{244}Pu by fast neutrons, 2:57608

PLUTONIUM DIOXIDE/BUBBLES
Equation-of-state and nonequilibrium bubble behavior during fast transients, 2:56799
PLUTONIUM DIOXIDE/CRITICALITY
Criticality safety in processing and handling fissile materials. Criticality data for plutonium 239-dioxide light-water-mixtures, 2:55877
PLUTONIUM DIOXIDE/DIFFUSION
Aerosol measurements and modeling for fast reactor safety. Task 7. Quarterly progress report, October 1-December 31, 1976 (LMFBR; time dependent aerosol suspension behavior), 2:56768 (BMI-NUREG-1969)
PLUTONIUM DIOXIDE/EVAPORATION
Evaporation kinetics of oxide fuels and their effect on the actinide redistribution in reactor fuel pins and on fuel vapor pressure under accident conditions, 2:56878 (EURFNR-1370)
PLUTONIUM DIOXIDE/FABRICATION
Fuels characterization in LMFBR, 2:56544
Preparation of mixed oxide nuclear fuel (Patent), 2:55874
PLUTONIUM DIOXIDE/FISSION PRODUCT RELEASE
Effect of solid fission products and dislocations on swelling and fission gas release in oxides during a fast overpower transient, 2:56800
PLUTONIUM DIOXIDE/PHYSICAL RADIATION EFFECTS
Postirradiation examinations of the BG-9 element, 2:56475 (ANL-8067)
PLUTONIUM ISOTOPES/BIOLOGICAL RADIATION EFFECTS
Plutonium in human lung in the Hanford environs, 2:57436 (BNWL-SA-5855)
PLUTONIUM ISOTOPES/RADIATION MONITORING
Plutonium in human lung in the Hanford environs, 2:57436 (BNWL-SA-5855)
PLUTONIUM NITRATES/CRITICALITY
Criticality safety in processing and handling fissile materials. Criticality data for plutonium 239 nitrate light-water-mixtures, 2:55878
PLUTONIUM NITRIDES/EQUATIONS OF STATE
Self-consistent normal fluid equation-of-state for (U,Pu)N, 2:56849
PLUTONIUM OXIDES/FABRICATION
Development of plutonium fuels in PNC, 2:56710
PLUTONIUM OXIDES/THERMODYNAMIC PROPERTIES
Thermodynamic functions and vapor pressures of uranium and plutonium oxides at high temperatures (From spectroscopy (third-law method)), 2:55867 (CONF-770537-2)
PLUTONIUM RECYCLE
Development of plutonium fuels in PNC, 2:56710
PLUTONIUM RECYCLE/ENERGY POLICY
Plutonium recycle's relation to the future of nuclear power, 2:56937
POINT CONTACTS
See ELECTRIC CONTACTS
POISEUILLE FLOW
See LAMINAR FLOW
POLAND/COAL MINES
Basaltic intrusion and its influence on coal in Seam 507 at Sosnica Colliery (12 refs), 2:55663
Determination of the probability of loosening the undermined coal seams in the light of the underground observations and theoretical consideration (5 refs), 2:55695
Determination of the optimum depression in methane-drainage boreholes in mines (2 refs), 2:55696
POLAND/HEAT FLOW
Heat flow map of Poland on the background of the European geothermal field and some aspects of its interpretation, 2:56187
POLAND/MINING EQUIPMENT
Poland's coal and lignite mining programme will ensure its future energy requirements, 2:55678
POLLUTION
(For nonradioactive pollution only; see also CONTAMINATION.)
See also AIR POLLUTION
CHEMICAL EFFLUENTS
THERMAL POLLUTION
WATER POLLUTION
POLLUTION/REMOTE SENSING
Tracking pollutants from a distance, 2:57366
POLLUTION CONTROL EQUIPMENT
See also CATALYTIC CONVERTERS
POLLUTION CONTROL EQUIPMENT/DESIGN
Air-fuel ratio regulating apparatus for an internal combustion engine with exhaust gas sensor characteristic compensation (Patent), 2:57081
Method of starting a combustion system utilizing a catalyst (Patent), 2:57086
Water injection device for internal combustion engines (Patent), 2:57079
POLLUTION CONTROL EQUIPMENT/TECHNOLOGY ASSESSMENT
Report of the Hearing Panel: National Public Hearing on Power Plant Compliance with Sulfur Oxide Air Pollution Regulations, conducted October 18, 1973 through November 2, 1973, 2:56346 (PB-264891)
POLYETHYLENES/EXTRUSION
Investigation of the process of extrusion of medium-pressure polyethylene-based tubes in connection with the prospect of their utilization in Azerbaijan oil industry, 2:57172
POLYETHYLENES/RESOURCE CONSERVATION
Substituting polyketones and polysulfones for polyethylene, 2:57171
POLYMER FLOODING
See MICROEMULSION FLOODING
POLYMERS
See also PLASTICS
SILICONES
POLYMERS/CHEMICAL RADIATION EFFECTS
Substituting polyketones and polysulfones for polyethylene, 2:57171
POLYNUCLEAR HYDROCARBONS
See CONDENSED AROMATICS
POLYSULFIDES
See SULFIDES
POLYURETHANES/NEUTRON RADIOGRAPHY
Fast-neutron gauging of polyurethane foam, 2:57311
PONDS (COOLING)
See COOLING PONDS
POROUS MATERIALS/FLUID FLOW
Stability of the replacement of a non-Newtonian fluid layer in a porous medium, 2:55765
PORTLAND CEMENT/COMPRESSION STRENGTH
Pressing of cement pastes, as well as the possibilities of utilizing this method for the purpose of determination of the quality of the cement, 2:57166 (LA-tr-77-26)
POSITRON COLLISIONS
See also POSITRON-ION COLLISIONS
POSITRON COLLISIONS/REVIEWS
Analysis of electron correlations, 2:57518
Negative ions, positive electrons, 2:57555
POSITRON-ION COLLISIONS/REVIEWS
Negative ions, positive electrons, 2:57555
POTASSIUM/ACTIVATION ANALYSIS
Determination of oxygen in reactive materials by 14-MeV neutron activation analysis, 2:57193
POTASSIUM/CORROSIVE EFFECTS
Compatibility of structural materials with boiling potassium (LMFBR), 2:56528 (CONF-760503-P1)
POTASSIUM/GAMMA SPECTROSCOPY
Uranium, thorium, and potassium content of Precambrian rocks, Upper Peninsula of Michigan and northern Wisconsin. Supplement to GJBX-48(76). Uranium and thorium occurrences in Precambrian rocks, Upper Penninsula of Michigan and northern Wisconsin, with thoughts on other possible settings, 2:57196 (GJBX-43(77))
POTASSIUM 40/RADIOECOLOGICAL CONCENTRATION
Concentrations of radionuclides and selected stable elements in fruits and vegetables, 2:57381 (CONF-770676-1)
POTASSIUM CHLORIDES/PHYSICAL RADIATION EFFECTS
Formation and dissociation of F centers in a KCl crystal as a result of pulsed irradiation (5-MeV electrons, 100 to 500°K, temperature dependence), 2:57187
POTASSIUM COMPLEXES/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance studies of diamagnetic metal-aminopolycarboxylate complexes, 2:57229
POWDER METALLURGY/ENERGY CONSUMPTION
Comparison of energy needs between conventional technologies and powder metallurgy, 2:57038
POWER DISTRIBUTION/CALCULATION METHODS
Method of calculation of detailed power distribution in fuel assemblies (LMFBR), 2:56567
POWER EXCURSIONS
See EXCURSIONS
POWER GENERATION/ENVIRONMENTAL IMPACTS
Health hazards of alternative electricity generation fuel cycles, 2:57404
POWER GENERATION/FUEL CONSUMPTION
Status of coal supply contracts for new electric generating units, 1976-1985, 2:56976 (PB-264769)
POWER GENERATION/HEALTH HAZARDS
Health hazards of alternative electricity generation fuel cycles, 2:57404
POWER GENERATION/INFORMATION SYSTEMS
Power engineering branch system of scientific and technical information in the tenth five year plan period, 2:56230
POWER GENERATION/LOW BTU GAS
Low-Btu gas from coal has many potential markets, 2:56966

POWER GENERATION/MANAGEMENT
Mergers create single French sources for nuclear, fossil, hydro plants, 2:56977
POWER GENERATION/REGIONAL ANALYSIS
Impacts of the western drought on regional electricity generation. Interim report, 2:56975 (PB-265 641)
POWER GENERATION/SOCIO-ECONOMIC FACTORS
Ultimate trade-off problem: comparative social impacts of electrical energy alternatives, 2:57405
POWER PLANTS
See also DUAL-PURPOSE POWER PLANTS
HYDROELECTRIC POWER PLANTS
NUCLEAR POWER PLANTS
SOLAR POWER PLANTS
TIDAL POWER PLANTS
WIND POWER PLANTS
POWER PLANTS/COOLING SYSTEMS
Methods for conveying and utilization of waste heat from power plants, 2:56341
POWER PLANTS/ENGINEERING
Results and problems of the new system of planning, financing and economic stimulation of research for development of new power engineering equipment, 2:56229
POWER PLANTS/ENVIRONMENTAL IMPACTS
Evaluation of alternative dry/wet cooling concepts for power stations, 2:56345
POWER PLANTS/TURBOMACHINERY
Setting up vibration reliability testing systems for parts and units of power plant equipment, 2:56329
POWER PLANTS/WASTE HEAT UTILIZATION
Methods for conveying and utilization of waste heat from power plants, 2:56341
POWER REACTORS
See also BLACK FOX-1 REACTOR
BLACK FOX-2 REACTOR
BOHUNICE A-1 REACTOR
BOR-60 REACTOR
BROWNS FERRY-1 REACTOR
BROWNS FERRY-2 REACTOR
BROWNS FERRY-3 REACTOR
CLINCH RIVER BREEDER REACTOR
DESALINATION REACTORS
DOEL-1 REACTOR
DOEL-2 REACTOR
EBR-2 REACTOR
HAMAOKA-1 REACTOR
HOPE CREEK-1 REACTOR
HOPE CREEK-2 REACTOR
JATR REACTOR
KNK REACTOR
KOZLODUY-1 REACTOR
KOZLODUY-2 REACTOR
LUCIE-1 REACTOR
MAGNOX TYPE REACTORS
MONJU REACTOR
NEP-1 REACTOR
NEP-2 REACTOR
OBRIGHEIM REACTOR
OKG-1 REACTOR
PEACH BOTTOM-1 REACTOR
PFR REACTOR
PHENIX REACTOR
PHIPPS BEND-1 REACTOR
PHIPPS BEND-2 REACTOR
PICKERING-3 REACTOR
PICKERING-4 REACTOR
PRESSURE TUBE REACTORS
PROCESS HEAT REACTORS
RANCHO SECO-1 REACTOR
RANCHO SECO-2 REACTOR
RWE-BAYERNWERK REACTOR
SGHWR REACTOR
SHIPPINGPORT REACTOR
SNR-1 REACTOR
THTR-300 REACTOR
WNP-1 REACTOR
WNP-2 REACTOR
WWER TYPE REACTORS
POWER REACTORS/BURNABLE POISONS
Control material behavior in commercial reactors, 2:56722
POWER REACTORS/FUEL ASSEMBLIES
Transient heat transfer in turbulent flow with time-dependent heat input, 2:56638 (JAERI-M-6597)
POWER REACTORS/FUEL MANAGEMENT
Interface between fuel management and nuclear fuel accounting, 2:56602
POWER REACTORS/IN CORE INSTRUMENTS
Apparatus for measuring neutron flux distribution in a reactor (Patent), 2:56698
POWER REACTORS/LOSS OF COOLANT
Calculation of the stationary mass velocity of steam mixtures and of the recoil forces occurring during LOCA, 2:56780 (IRS-W-24)
POWER REACTORS/NEUTRON ABSORBERS
Control material behavior in commercial reactors, 2:56722
POWER REACTORS/NEUTRON MONITORS
Measurement of Nb 93m activity determining the fluence of fast neutrons in power reactors, 2:56665
POWER REACTORS/ON-LINE CONTROL SYSTEMS
Reactor control system (Patent), 2:56736
POWER REACTORS/PRESSURE VESSELS
Model for fracture mechanical estimation of the failure probability of reactor pressure vessels, 2:56673
Statistical methods for interpreting fatigue crack growth data with applications to reactor pressure vessel steels, 2:56677
POWER REACTORS/REACTIVITY INSERTIONS
Generator of reactivity functions, 2:56640
POWER REACTORS/REACTOR OPERATION
Experience in diagnostic and surveillance methods development, 2:56363
Power plant surveillance and diagnostics research and development needs, 2:56364
POWER REACTORS/REACTOR PROTECTION SYSTEMS
Risk assessment to determine the advisability of seismic trip systems, 2:56863
POWER REACTORS/SHIELDS
Application of conversational procedure to optimization of multi-layer radiation shielding design, 2:56689
Shielding construction for a reactor (Patent), 2:56700
POWER REACTORS/TABLES
Nuclear reactors built, being built, or planned in the United States as of June 30, 1977, 2:56362 (TID-8200-R36)
POWER SUBSTATIONS/CONTROL SYSTEMS
Process computer in electric substations, 2:56350
Rekatic, a control and monitoring system for transformer stations, 2:56353
POWER SUPPLIES/FAILURES
Failure probability of the battery system following loss of ac power, 2:56862
POWER SYSTEMS
See also AC SYSTEMS
POWER SYSTEMS/CONTROL
Investigation of operating conditions of nuclear power plants during emergency shortages of power in the electric power system, 2:56389
POWER SYSTEMS/CONTROL SYSTEMS
Remote terminal units, 2:56354
POWER SYSTEMS/RELIABILITY
Various methods of studying the reliability of power systems, 2:56351
POWER SYSTEMS/STABILITY
Few aspects of the behavior of a cryogenerator in a big electric system, 2:57269
POWER SYSTEMS/STEADY-STATE CONDITIONS
Investigations related to the calculation of steady-state conditions of electric systems comprising long ac and dc electric power lines, 2:56358
POWER TRANSMISSION LINES
See also CURRENT LIMITERS
POWER TRANSMISSION LINES/DESIGN
Report of feasibility of high phase order transmission, 2:56355 (CONS/2066-1)
POWER TRANSMISSION LINES/ECONOMICS
Report of feasibility of high phase order transmission, 2:56355 (CONS/2066-1)
POWER TRANSMISSION LINES/ENVIRONMENTAL IMPACT STATEMENTS
Environmental impact analysis of Coyote Station. Volume 2 (345 kV transmission system with 115 kV connection), 2:56357 (NP-22244(Vol.2))
POWER TRANSMISSION LINES/FAILURES
Outage at Gundremmingen nuclear power plant caused by cold weather, 2:56378
POWER TRANSMISSION LINES/PERFORMANCE
Report of feasibility of high phase order transmission, 2:56355 (CONS/2066-1)
POWER TRANSMISSION LINES/TRANSIENTS
computational experiment in the investigation of electromagnetic transient processes in electric power transmission lines, 2:56352
PRECIPITATION SCAVENGING/BIBLIOGRAPHIES
Bibliography on precipitation chemistry (subject index), 2:57350 (NP-21685)
PRECIPITATIONS (ATMOSPHERIC)
See ATMOSPHERIC PRECIPITATIONS
PRESSURE SUPPRESSION/HYDRODYNAMICS
Reactor containment analysis for BWR suppression systems. Progress report for January-March 1977, 2:56795 (UCRL-50045-77-1)

PRESSURE TUBE REACTORS/REACTOR CORES
Core construction in a pressure tube type heavy water reactor (Patent), 2:56472
Pressure tube reactor (Patent), 2:56471
PRESSURE (VAPOR)
See VAPOR PRESSURE
PRESSURE VESSELS
Cylindrical prestressed concrete tank for a nuclear power plant (Patent; HTGR), 2:56432
PRESSURE VESSELS/CRACKS
Significance of reheat cracks to the integrity of pressure vessels for light-water reactors, 2:56367 (ORNL/NUREG-15)
Statistical methods for interpreting fatigue crack growth data with applications to reactor pressure vessel steels, 2:56677
Stress intensities in flawed pressure vessels, 2:57256
PRESSURE VESSELS/DESIGN
Feasibility study of prestressed concrete pressure vessels for coal gasifiers, 2:55583 (ORNL-5312)
Gas-cooled nuclear reactor with a pressure vessel with liners (Patent), 2:56444
High pressure apparatus for hydrogen isotopes to pressures of 345 MPa (50,000 psi) and temperatures of 1200°C, 2:57253 (UCRL-78886)
Material manufacturing and fabrication of ultra-large size hydrodesulphurization reactors, 2:57263
Study of heat transfer through refractory lined gasifier vessel walls. Quarterly progress report, December 1976-February 1977, 2:55573 (FE-2210-12)
Treatment of the influence of irradiation in design and operation control of pressure vessels of pressurized- and boiling-water reactors, 2:56380
PRESSURE VESSELS/FABRICATION
A-508 class 3 forgings for pressure vessels (PWR), 2:56420
Manufacture of multi-layered casings of stationary apparatus and problems of their strength, 2:56695
Material manufacturing and fabrication of ultra-large size hydrodesulphurization reactors, 2:57263
Production of components for pressurized water reactors in the plants of FRAMATOME, 2:56421
Production of components for pressurized water reactors in the plants of Framatome, 2:56422
PRESSURE VESSELS/FAILURE MODE ANALYSIS
Failure assessment of pressure vessels under yielding conditions, 2:56675
PRESSURE VESSELS/FATIGUE
Cyclic stress strain behavior of four nuclear pressure vessel materials, 2:56676
PRESSURE VESSELS/FEASIBILITY STUDIES
Feasibility study of prestressed concrete pressure vessels for coal gasifiers, 2:55583 (ORNL-5312)
PRESSURE VESSELS/FRACTURE PROPERTIES
Improvement of fracture toughness in reactor pressure vessel steel plates (BWR; PWR; ASTM-A533-B), 2:56385
Initiation and arrest: two approaches to pressure vessel safety, 2:56873
Model for fracture mechanical estimation of the failure probability of reactor pressure vessels, 2:56673
PRESSURE VESSELS/HEAT TRANSFER
Study of heat transfer through refractory lined gasifier vessel walls. Quarterly progress report, December 1976-February 1977, 2:55573 (FE-2210-12)
PRESSURE VESSELS/MEETINGS
Pressure vessel technology. I. Analysis, design, and inspection, 2:56667
Pressure vessel technology. II. Materials and fabrication, 2:56671
PRESSURE VESSELS/NONDESTRUCTIVE TESTING
Behavior of flawed pressure vessels, 2:57208
PRESSURE VESSELS/NOZZLES
Corner crack at a nozzle, 2:56672
Fatigue and fracture behaviour of cracks at nozzle corners: comparison of theoretical predictions with experimental data, 2:57260
Novel design for LWR pressure vessel nozzles and corresponding stress analysis, 2:56383
PRESSURE VESSELS/PERFORMANCE TESTING
Behavior of flawed pressure vessels, 2:57208
Lifetimes of fiber composites under sustained tensile loading, 2:57252 (UCRL-78367)
PRESSURE VESSELS/PIPE JOINTS
Studies on the fatigue of branched connections related to the shakedown pressure, 2:57258
PRESSURE VESSELS/RELIABILITY
Failure assessment of pressure vessels under yielding conditions, 2:56675
Model for fracture mechanical estimation of the failure probability of reactor pressure vessels, 2:56673
PRESSURE VESSELS/RESIDUAL STRESSES
Analysis of residual stresses/strains in pressure vessels due to cyclic thermomechanical loads, 2:56281
PRESSURE VESSELS/STEELS
Neutron exposure for safety limitation for reactor pressure vessel steels, 2:57140 (AED-Conf-76-556-004)
PRESSURE VESSELS/STRESS ANALYSIS
Analysis of residual stresses/strains in pressure vessels due to cyclic thermomechanical loads, 2:56281
Application of a general purpose finite element program system in pressure vessel technology, 2:56668
High pressure vessel flange behavior under transient thermal loadings (BWR; PWR), 2:56384
Post-yield fracture mechanics theory and its application to pressure vessels, 2:56659
Significance of reheat cracks to the integrity of pressure vessels for light-water reactors, 2:56367 (ORNL/NUREG-15)
Stress intensities in flawed pressure vessels, 2:57256
PRESSURE VESSELS/WELDED JOINTS
Fatigue behavior of nozzles of light water reactor pressure vessel model, 2:56387
Transient and residual stresses from multipass weld in very thick plates and their reduction from stress relief annealing, 2:57262
PRESSURIZED WATER REACTORS
See PWR TYPE REACTORS
PRIMARY COOLANT CIRCUITS/DESIGN
Reactor (Patent; LMFBR), 2:56574
Reactor (Patent; LMFBR), 2:56575
Reactor apparatus (Patent; LMFBR), 2:56573
PRIMARY COOLANT CIRCUITS/FISSION PRODUCTS
Fission product measurements in the inpile fission product loop (LMFBR), 2:56514 (CONF-760503-P1)
PRIMARY COOLANT CIRCUITS/RADIOACTIVITY TRANSPORT
Fission product measurements in the inpile fission product loop (LMFBR), 2:56514 (CONF-760503-P1)
Fission product deposition in a stainless steel sodium system (LMFBR: SS-304), 2:56515 (CONF-760503-P1)
PRIMARY COOLANT CIRCUITS/REACTOR ACCIDENTS
Experimental studies on sodium fires application to reactors (LMFBR), 2:56580 (NP-tr-1980)
PRINCETON LARGE TORUS
See PLT DEVICES
PROCESS CONTROL/MATHEMATICAL MODELS
Investigation of the functioning of an industrial process, 2:56424
PROCESS HEAT/SOLAR ENERGY
Characterization of industrial process heat, including the potential for solar or nuclear systems to supply this market, 2:56094
Industrial applications of solar energy. Quarterly report, 2:56093 (SAN/1132-1)
PROCESS HEAT REACTORS/COAL GASIFICATION
Germany plans process heat schemes for HTGR, 2:56609
Materials for steam gasification of coal with HTR heat (6 refs), 2:55593
Status report at the end of the concept phase, 1 August 1975-30 November 1976 (Nuclear coal gasification), 2:55590 (ERDA-tr-296)
PROCESS HEAT REACTORS/ECONOMICS
Studies of a small PWR for onsite industrial power, 2:56608 (CONF-770403-15)
PROCESS HEAT REACTORS/HEAT EXCHANGERS
Application of boiling liquid metals in industrial processes, 2:56607 (CONF-760503-P1)
PROCESS HEAT REACTORS/HYDROGEN PRODUCTION
High temperature corrosion in the thermochemical hydrogen production from nuclear heat, 2:55975
Method for the production of hydrogen by water splitting (Patent), 2:56614
Plant for producing hydrogen by utilizing the thermal energy generated in a gas-cooled high-temperature reactor (Patent), 2:56612
PROCESS HEAT REACTORS/INDUSTRY
Studies of a small PWR for onsite industrial power, 2:56608 (CONF-770403-15)
PROCESS HEAT REACTORS/REACTOR MATERIALS
High temperature materials requirements in reforming of gaseous hydrocarbons with HTR heat, 2:56613
PROCESSING (WASTES)
See WASTE PROCESSING
PRODUCTION REACTORS
(For the production of fissile materials only; see also IRRADIATION REACTORS.)
PRODUCTION REACTORS/TABLES
Nuclear reactors built, being built, or planned in the United States as of June 30, 1977, 2:56362 (TID-8200-R36)
PROGRAMMING/MATHEMATICAL MODELS
Specialization of SARA for software synthesis, 2:57819 (UCLA-34P214-37)
PROGRAMMING/RECOMMENDATIONS
Software engineering techniques in design automation: a tutorial, 2:57827 (UCRL-79426)

PROJECT INDEPENDENCE
Project Independence evaluation system (PIES) documentation. Volume VI. Methodology for improving the price sensitivity of the PIES oil and gas supply curves, 2:56950 (PB-264069)
PROJECT INDEPENDENCE/ENERGY SUPPLIES
Project Independence evaluation system (PIES) documentation. Volume VII. Methodology for developing more complex investment and production profiles in the FEA oil and gas supply model, 2:56951 (PB-264649)
PROPANE/TRANSPORT
Some problems of hydraulic calculation of gas pipelines transporting gas and air mixture, 2:55824
PROPANOLS/COMBUSTION
Investigation of the effect of nitrogen-containing fuel additives on the formation of nitrogen oxides, 2:55805
PROPENE
See PROPYLENE
PROPINE
See PROPYNE
PROPYLENE/CRYSTALLOGRAPHY
Surface crystallography of clean platinum single crystals and adsorbed hydrocarbon overlayers studied by low energy electron diffraction, 2:57211 (LBL-6221)
PROPYNE/CRYSTALLOGRAPHY
Surface crystallography of clean platinum single crystals and adsorbed hydrocarbon overlayers studied by low energy electron diffraction, 2:57211 (LBL-6221)
PROTECTION (RADIATION)
See RADIATION PROTECTION
PROTECTIVE COATINGS/AGING
Aging of silazane protective coating in vacuum, 2:56124
PROTECTIVE COATINGS/OPTICAL PROPERTIES
Utilization of transparent heat reflecting coatings in solar energy converters, 2:56055
PROTON REACTIONS/PARTICLE PRODUCTION
Results of the search for the intermediate W boson in proton-nucleus collisions at 70 GeV, 2:57565
PROTON REACTIONS/SPALLATION
Inelastic interaction of high energy particles with light nuclei and the cluster structure of nuclei (660 MeV; differential cross sections), 2:57593
PROTON-ANTIPROTON INTERACTIONS/DIFFERENTIAL CROSS SECTIONS
Comparison of the line-reversed channels p-barp $\pi^-\pi^+$ and π^+ p $p\pi^+$ at 6 GeV/c, 2:57566
PROTON-DEUTERON INTERACTIONS/MULTIPLE SCATTERING
Double scattering in deuterium as a probe of hadron structure, 2:57583
PROTON-DEUTERON INTERACTIONS/PARTICLE PRODUCTION
Production of ultrafast pions in collisions of relativistic deuterons with protons and nuclei, 2:57584
PROTON-PROTON INTERACTIONS/ELASTIC SCATTERING
Elastic π^+ p, K^+ p, and pp scattering in the region of Coulomb-nuclear interference at momenta 42.5 and 52.2 GeV/c, 2:57569
PROTON-PROTON INTERACTIONS/TOTAL CROSS SECTIONS
Elastic π^+ p, K^+ p, and pp scattering in the region of Coulomb-nuclear interference at momenta 42.5 and 52.2 GeV/c, 2:57569
PROTOTYPE FAST REACTOR (DOUNREAY)
See PFR REACTOR
PSI RESONANCES/DECAY
Intermultiplet mixing of the vector mesons in a nonperturbative approach to broken SU(4), 2:57586
PSI RESONANCES/REVIEWS
From the psi to charm: the experiments of 1975 and 1976, 2:57568
PSI-3695 RESONANCES/DECAY
Radiative transitions in the charmonium model, 2:57573
PUBLIC UTILITIES/CONTROL SYSTEMS
Determination of the annual economic effect of automation of control of an electric utility enterprise, 2:56921
PULSED FUSION REACTORS/MAGNETIC ENERGY STORAGE
Electrical breakdown and tracking characteristics of pulsed high voltages in cryogenic helium and nitrogen, 2:57742
PUMPED STORAGE
Utilization of solar radiation at large solar power plants with hydraulic storage, 2:56083
PUMPED STORAGE/AVAILABILITY
Report on the Western Energy Expansion Study, 2:56986 (NP-22295)
PUMPED STORAGE POWER PLANTS/DESIGN
Pumped storage hydroelectric plants, 2:56885
PUMPS
See also ELECTROMAGNETIC PUMPS
SOLAR WATER PUMPS
TURBOMACHINERY
PUMPS/COST
Feed pump drives - a cost comparison between steam turbine and electric-driven propulsion, 2:56683
PUMPS/DESIGN
Hydrodynamic theory of supercavitating pumps or hydroturbines, 2:56007
PUMPS/EFFICIENCY
Effect of the frequency of rotation on the efficiency of a centrifugal pump with a low n/sub s/, 2:56684
PUMPS/ELECTRIC MOTORS
Rectifier motor as a drive for axial pumps, 2:56693
PUMPS/MATERIALS
Status of Wilsonville Solvent Refined Coal pilot plant. Interim report, 2:55601 (EPRI-1234)
PUMPS/SEALS
End face seals in high pressure water--learning from those failures, 2:56473
PUMPS/SERVICE LIFE
Status of Wilsonville Solvent Refined Coal pilot plant. Interim report, 2:55601 (EPRI-1234)
PUMPS/STRESS ANALYSIS
Thermoplastic analysis of a pump body in a primary circuit nuclear application (PWR), 2:56419
PUROMYCIN/BIOLOGICAL EFFECTS
Nitrate uptake by dark-grown corn seedlings. Some characteristics of apparent induction, 2:57419
PUROX PYROLYSIS PROCESS/OPTIMIZATION
Pyrolysis process for converting refuse to fuel gas (Patent; optimization of Purox Pyrolysis Process), 2:55993
PWR TYPE REACTORS
See also CE STANDARD REACTOR
DOEL-1 REACTOR
DOEL-2 REACTOR
KOZLODUY-1 REACTOR
KOZLODUY-2 REACTOR
LOFT REACTOR
LUCIE-1 REACTOR
NEP-1 REACTOR
NEP-2 REACTOR
OBRIGHEIM REACTOR
RANCHO SECO-1 REACTOR
SHIPPINGPORT REACTOR
WNP-1 REACTOR
WWER TYPE REACTORS
Assessment of underground siting of a nuclear power plant with PWR as an engineered safety feature, 2:56809
PWR TYPE REACTORS/BURNABLE POISONS
C-E burnable poison irradiation test program. (CEN No. 50), 2:56721 (NP-22113)
PWR TYPE REACTORS/CORE FLOODING SYSTEMS
Effect of superheated walls on plenum filling at 1/15 scale. Quarterly progress report, October 1, 1976-December 31, 1976, 2:56773 (CREARE-TN-255)
Reflood simulation study of the FLECHT-SET system using RELAP4/MOD6, 2:56810
Self-initialization of the RELAP4 momentum equation, 2:56811
PWR TYPE REACTORS/DEPARTURE NUCLEATE BOILING
Response surface methodology applied to thermal-hydraulic margin analysis, 2:56864
PWR TYPE REACTORS/ECCS
Assessment of emergency core cooling system effectiveness for light water nuclear power reactors, 2:56881
Semiscale Mod-1 system response during the ECC baseline test series (design of the Mod-1 baseline ECC test), 2:56408 (TREE-NUREG-1058)
Steam-water mixing and system hydrodynamics program. Task 4. Quarterly progress report, October-December 1976, 2:56767 (BMI-NUREG-1968)
PWR TYPE REACTORS/ECONOMICS
Studies of a small PWR for onsite industrial power, 2:56608 (CONF-770403-15)
PWR TYPE REACTORS/EVALUATION
Investigation of operating conditions of nuclear power plants during emergency shortages of power in the electric power system, 2:56389
PWR TYPE REACTORS/EXCURSIONS
Cladding temperatures, deformations, and failure thresholds during power bursts, 2:56807
PWR TYPE REACTORS/FUEL ASSEMBLIES
Combined seismic-LOCA mechanical evaluation for Exxon Nuclear 15 x 15 reload fuel for Westinghouse PWR's, 2:56797 (XN-76-47(NP))
PWR TYPE REACTORS/FUEL CYCLE
Investigation of conditions of operation of nuclear power plants with water-cooled power reactors, 2:56394
Nuclear fuel cycle: (4) the reactors, 2:56606
PWR TYPE REACTORS/FUEL ELEMENT CLUSTERS
On two-phase thermal boundary layer along heated walls, 2:56395

PWR TYPE REACTORS/FUEL ELEMENTS
Behavior of irradiated fuel rods during film boiling operation, 2:56808
FRAP-S2: a computer code for the steady state analysis of oxide fuel rods, 2:56369 (TREE-NUREG-1107)
Operational experience with Westinghouse cores (up to December 31, 1976), 2:56409 (WCAP-8183(Rev.6))
Release of fission gas from high-burnup fuel during transient heating, 2:56372
PWR TYPE REACTORS/FUEL MANAGEMENT
Code to assist in teaching nuclear fuel management, 2:56622
Investigation of conditions of operation of nuclear power plants with water-cooled power reactors, 2:56394
PWR TYPE REACTORS/FUEL PELLETS
Effect of pellet cracking on light water reactor fuel temperatures, 2:56392
PWR TYPE REACTORS/INDUSTRY
Studies of a small PWR for onsite industrial power, 2:56608 (CONF-770403-15)
PWR TYPE REACTORS/LOSS OF COOLANT
Analysis of LWR post-LOCA gamma ray energy redistribution, 2:56806
Analysis of Standard Problem 2 with the TRAC-1D Code, 2:56812
Behavior of inner surface oxidation of the zircaloy cladding tube in a loss-of-coolant accident, 2:56783 (JAERI-M-6602)
Combined seismic-LOCA mechanical evaluation for Exxon Nuclear 15 x 15 reload fuel for Westinghouse PWR's, 2:56797 (XN-76-47(NP))
Oxygen concentration distribution in β-phase of the Zry-4 cladding during Zr-steam reaction at LOCA, 2:56781 (JAERI-M-6538)
Steam-water mixing and system hydrodynamics program. Task 4. Quarterly progress report, October-December 1976, 2:56767 (BMI-NUREG-1968)
PWR TYPE REACTORS/NEUTRON FLUX
Neutron flux calculations with regard to radiation damage, explained for the geometry of a KWU 1300-MWe PWR facility, 2:56416
PWR TYPE REACTORS/OFF-PEAK ENERGY STORAGE
Energy storage in the form of latent heat, 2:56388
PWR TYPE REACTORS/PIPES
Characteristics of pipe system failures in light-water reactors, 2:56861
Fracture in straight pipes under large deflection conditions. II. Pipe pressures, 2:56374
PWR TYPE REACTORS/PRESSURE VESSELS
A-508 class 3 forgings for pressure vessels, 2:56420
Fatigue behavior of nozzles of light water reactor pressure vessel model, 2:56387
High pressure vessel flange behavior under transient thermal loadings, 2:56384
Improvement of fracture toughness in reactor pressure vessel steel plates, 2:56385
Novel design for LWR pressure vessel nozzles and corresponding stress analysis, 2:56383
Production of components for pressurized water reactors in the plants of FRAMATOME, 2:56421
Production of components for pressurized water reactors in the plants of Framatome, 2:56422
Significance of reheat cracks to the integrity of pressure vessels for light-water reactors, 2:56367 (ORNL/NUREG-15)
Treatment of the influence of irradiation in design and operation control of pressure vessels of pressurized- and boiling-water reactors, 2:56380
PWR TYPE REACTORS/PROCESS CONTROL
Investigation of the functioning of an industrial process, 2:56424
PWR TYPE REACTORS/PUMPS
Thermoplastic analysis of a pump body in a primary circuit nuclear application, 2:56419
PWR TYPE REACTORS/REACTOR COMPONENTS
Assessment of toughness and cracking in the heat-affected zone of light water reactor components, 2:56386
PWR TYPE REACTORS/REACTOR CONTROL SYSTEMS
Instrumentation qualification. Seismic qualification of C-E instrumentation equipment. Part One, 2:56769 (CENPD-182(Pt.1))
Instrumentation qualification. Seismic qualification of C-E instrumentation equipment. Part Two, 2:56770 (CENPD-182(Pt.2))
Reactor capacity-control technique. Development of KWU/PWR's during the past 10 years and development tendencies, 2:56733
PWR TYPE REACTORS/REACTOR CORES
Operational experience with Westinghouse cores (up to December 31, 1976), 2:56409 (WCAP-8183(Rev.6))
PWR TYPE REACTORS/REACTOR INSTRUMENTATION
Instrumentation qualification. Seismic qualification of C-E instrumentation equipment. Part One, 2:56769 (CENPD-182(Pt.1))
Instrumentation qualification. Seismic qualification of C-E instrumentation equipment. Part Two, 2:56770 (CENPD-182(Pt.2))
PWR TYPE REACTORS/REACTOR OPERATION
Investigation of conditions of operation of nuclear power plants with water-cooled power reactors, 2:56394
Investigation of operating conditions of nuclear power plants during emergency shortages of power in the electric power system, 2:56389
Nuclear power plant operating experience, 1974-1975, 2:56586 (PB-265794)
Operating U.S. power reactors, 2:56382
PWR TYPE REACTORS/REACTOR SAFETY
Evaluation of human errors in commercial light-water reactors, 2:56859
Reports on the research projects in the field of reactor safety sponsored by the Federal Ministry of Science and Technology. Period under report: July 1st to September 30th, 1976, 2:56779 (IRS-F-33)
Steam-water mixing and system hydrodynamics program. Task 4. Quarterly progress report, October-December 1976, 2:56767 (BMI-NUREG-1968)
PWR TYPE REACTORS/SEISMIC EFFECTS
Combined seismic-LOCA mechanical evaluation for Exxon Nuclear 15 x 15 reload fuel for Westinghouse PWR's, 2:56797 (XN-76-47(NP))
PWR TYPE REACTORS/SPENT FUEL STORAGE
B and W-designed close-spaced fuel storage racks, 2:56412
Spent nuclear fuel: prospects for output, storage and reprocessing, 2:56373
Westinghouse high-density spent fuel rack design, 2:56411
PWR TYPE REACTORS/SPENT FUELS
Spent nuclear fuel: prospects for output, storage and reprocessing, 2:56373
PWR TYPE REACTORS/STEAM GENERATORS
Benefit of using a global tridimensional finite element calculation for the analysis of the primary part of a PWR steam generator, 2:56418
Production of components for pressurized water reactors in the plants of FRAMATOME, 2:56421
Production of components for pressurized water reactors in the plants of Framatome, 2:56422
PWR-80 TYPE REACTORS
See CE STANDARD REACTOR
PYRANOMETERS/CALIBRATION
Pyranometer calibration: leveling errors and cosine effect, 2:56023 (SAND-77-1047C)
PYRIDINE/PYROLYSIS
Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, 11 September-10 December 1976 (5 refs), 2:55723 (FE-2018-6)
Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, December 11, 1976-March 10, 1977, 2:55724 (FE-2018-7)
PYRIDINE/SOLVENT PROPERTIES
Oxidations of coal, coal fractions, and coal models (9 refs), 2:55637 (CONF-760885-)
PYRIDINES/CHEMICAL REACTION KINETICS
Reaction of Type II biradicals with paraquat ions. Measurement of biradical lifetimes, 2:57230
PYRITE/FLOTATION
Floatability of coal and pyrite (54 references), 2:55553 (IS-T-779)
PYRITE/REMOVAL
Sulfur, moisture and ash reduction in coal preparation research (11 refs), 2:55554
PYROLYTIC CARBON/DEPOSITION
Fuel particles with coatings without property gradients (Patent), 2:55869

Q

QUANTUM ELECTRODYNAMICS/RADIATIVE CORRECTIONS
Radiative corrections to the classical Lagrangian and dynamical symmetry breaking, 2:57587
QUARTZ/PHYSICAL RADIATION EFFECTS
Direct observation of the dynamics of picosecond-pulse optical breakdown, 2:57183

R

RADIATION BELTS/DOSE RATES
Charged-particle radiation environment for the Spacelab and other missions in low Earth orbit, revision A, 2:57492 (N-77-16979)
RADIATION DETECTORS
See also GAMMA CAMERAS
LOW LEVEL COUNTERS
NEUTRON DETECTORS
RADIATION MONITORS
RADIATION DETECTORS/SENSITIVITY
Informational threshold of sensitivity of radiation detectors, 2:57333
RADIATION HYGIENE
See RADIATION PROTECTION
RADIATION MONITORING/STATISTICAL MECHANICS
Ratio estimation techniques in the analysis of environmental radionuclide data, 2:57379 (BNWL-SA-5975(Rev.))
RADIATION MONITORS
See also NEUTRON MONITORS
RADIATION MONITORS/DESIGN
Activity measuring point, especially in a nuclear power station (Patent), 2:57334
RADIATION PROTECTION
Estimation and control of population dose within buildings, 2:57432
Radiological criteria for release of land and for decommissioning facilities, 2:56588
RADIATION PROTECTION/EDUCATION
Interdisciplinary graduate program to prepare science majors for careers in Radiation Health Physics, 2:57462
Non-ionizing radiation protection training manual for radiation control. Lectures, demonstrations, laboratories and tours on the course on non-ionizing radiations. Final report, 2:57431 (PB-264888)
Role of nuclear laboratory courses at Purdue University, 2:56616
RADIATION SAFETY
See RADIATION PROTECTION
RADIATORS/DESIGN
Design of energy-integrated building subsystems and their evaluation, 2:57012
RADIOACTIVE AEROSOLS
Aerosol attenuation in leakage paths (LMFBR accident analysis), 2:56819
Aerosols in nuclear engineering, 2:56880
RADIOACTIVE AEROSOLS/AEROSOL MONITORING
ERDA's National Aerial Radiometric and Magnetic Survey, 2:57385
RADIOACTIVE AEROSOLS/CONTAINMENT
Aerosol measurements and modeling for fast reactor safety. Task 7. Quarterly progress report, October 1-December 31, 1976 (LMFBR; time dependent aerosol suspension behavior), 2:56768 (BMI-NUREG-1969)
RADIOACTIVE AEROSOLS/PARTICLE SIZE
First-generation model to predict particle-size distributions for condensed UO_2 vapor, 2:56821
RADIOACTIVE AEROSOLS/RADIONUCLIDE MIGRATION
Selecting probability for use in direction-dependent accident dispersion models consistent with past NRC practice, 2:56858
RADIOACTIVE AEROSOLS/REMOVAL
Containers for radioactive aerosols (Patent; LMFBR), 2:56571
RADIOACTIVE BIOLOGICAL WASTES
See RADIOACTIVE WASTES
RADIOACTIVE EFFLUENTS
See also RADIOACTIVE WASTES
RADIOACTIVE EFFLUENTS/CLEANING
Recovery from spillage of calcined waste solids, 2:55904
RADIOACTIVE EFFLUENTS/RADIATION MONITORING
Activity measuring point, especially in a nuclear power station (Patent), 2:57334
Remote monitoring system for nuclear reactors, 2:56751
RADIOACTIVE MATERIALS/LICENSING
Regulation of naturally occurring and accelerator-produced radioactive materials. A Task Force review, 2:57430 (NUREG-0301)
RADIOACTIVE MATERIALS/SAFETY STANDARDS
Regulation of naturally occurring and accelerator-produced radioactive materials. A Task Force review, 2:57430 (NUREG-0301)
RADIOACTIVE MATERIALS/TRANSPORT
Safety Analysis Report for Packaging (SARP): ATMX-500 Railcar nuclear packaging, 2:57277 (MLM-2428)
Transportation R and D in ERDA's Division of Environmental Control Technology, 2:55888
RADIOACTIVE WASTE DISPOSAL
Fusion-driven actinide burner design study. Final report, 2:57755 (EPRI-ER-451(Vol.1)(5-77))
Fusion-driven actinide burner design study. Final report, 2:57756 (EPRI-ER-451(Vol.2)(5-77))
Radioactive residual matter. II, 2:55728
Waste management procedures for CTR central power stations, 2:57762
RADIOACTIVE WASTE DISPOSAL/GEOLOGIC DEPOSITS
Management and storage of commercial power reactor wastes, 2:55899 (ERDA-76-162)
RADIOACTIVE WASTE DISPOSAL/INTERNATIONAL COOPERATION
Prospect of international cooperation on high-level-waste disposal on the ocean floor, 2:55929
RADIOACTIVE WASTE DISPOSAL/MARINE DISPOSAL
Oceanic distributions of radionuclides from nuclear weapons testing, 2:55927
Oceanographic processes and the ultimate disposal of high-level radioactive waste, 2:55930
Political and legal implications of radioactive waste disposal at sea, 2:55931
Prospect of international cooperation on high-level-waste disposal on the ocean floor, 2:55929
U.S. seabed high-level radioactive waste disposal feasibility study, 2:55928
RADIOACTIVE WASTE DISPOSAL/MILL TAILINGS
Geology and hydrology in the vicinity of the inactive uranium mill tailings pile, Ambrosia Lake, New Mexico, 2:55935 (LA-6839-MS)
RADIOACTIVE WASTE DISPOSAL/RADIATION MONITORING
Status report: borehole monitoring of radioactive waste trenches 1965-1974, 2:55932 (DPST-76-254)
RADIOACTIVE WASTE DISPOSAL/RESEARCH PROGRAMS
Summary of geologic review group meeting, January 20-21, 1977, 2:55919 (Y/OWI/TM-8/1)
RADIOACTIVE WASTE DISPOSAL/RISK ASSESSMENT
Contributions to the risk analysis of a repository for high-level radioactive wastes in geologic salt formations, 2:55923
Long-term risk assessment of radioactive waste disposal in geological formations, 2:55951
Risk comparison of alternatives of the back end of the fuel cycle at a pre-project stage, 2:55946
RADIOACTIVE WASTE DISPOSAL/SAFETY
Proposed outline for a safety analysis report for a radioactive waste repository, 2:55917 (Y/OWI/SUB-76/7253/1)
RADIOACTIVE WASTE DISPOSAL/SALT DEPOSITS
Calculations of radioactivity release due to leaching of vitrified high-level waste, 2:55922
Conceptual design criteria for facilities for geologic disposal of radioactive wastes in salt formations, 2:55920 (Y/OWI/TM-9)
Contributions to the risk analysis of a repository for high-level radioactive wastes in geologic salt formations, 2:55923
RADIOACTIVE WASTE DISPOSAL/UNDERGROUND DISPOSAL
Leaching of solidified radioactive waste, 2:55921
Waste trench cap study of remedial work for West Valley, 2:55925
West Valley waste burial area problems correlated to operating practices, 2:55924
RADIOACTIVE WASTE FACILITIES/DESIGN
Conceptual design criteria for facilities for geologic disposal of radioactive wastes in salt formations, 2:55920 (Y/OWI/TM-9)
RADIOACTIVE WASTE FACILITIES/RADIOACTIVE EFFLUENTS
Recovery from spillage of calcined waste solids, 2:55904
RADIOACTIVE WASTE FACILITIES/RISK ASSESSMENT
Contributions to the risk evaluation of a high-level waste solidification plant, 2:55947
RADIOACTIVE WASTE MANAGEMENT
See also RADIOACTIVE WASTE STORAGE
But what will be done with the high level radioactive waste. Surely man can improve on nature, 2:56934
Integrated radioactive defense waste management plan (Savannah River Plant), 2:55916 (SRO-TWM-77-1)
Management and storage of commercial power reactor wastes, 2:55899 (ERDA-76-162)
Performance calculations of fast reactor actinide recycle as a waste management alternative (Fissioning the actinides), 2:55926
Secure storage of radioactive waste (State-of-the-art survey), 2:55897
RADIOACTIVE WASTE MANAGEMENT/RISK ASSESSMENT
Criteria for assessing radioactive waste management schemes, 2:55953
Perspectives on risk assessment for radioactive waste management systems, 2:55942
Risk analysis of radioactive waste management systems in Germany, 2:55944
Risk assessment method for nuclear fuel cycle operations, 2:55943

RADIOACTIVE WASTE MANAGEMENT/SOLID WASTES
Determination of performance criteria for high-level solidified nuclear waste, 2:55896 (NUREG-0279)
RADIOACTIVE WASTE MANAGEMENT/STANDARDS
Determination of performance criteria for high-level solidified nuclear waste, 2:55896 (NUREG-0279)
RADIOACTIVE WASTE PROCESSING/COMBUSTION
Volume reduction system for solid and liquid TRU waste from the nuclear fuel cycle: January-March 1977 (Ash immobilization), 2:55901 (MLM-2436)
RADIOACTIVE WASTE PROCESSING/EVAPORATION
Alternative fuel cycle technology progress report for April 1-June 30, 1977, 2:55900 (ICP-1122)
RADIOACTIVE WASTE PROCESSING/LIQUID WASTES
Method of preparation for storage of liquids used in the reprocessing of spent nuclear fissile and/or fertile materials (Patent), 2:55885
RADIOACTIVE WASTE PROCESSING/REMOTE HANDLING EQUIPMENT
Remote maintenance equipment for the new waste calcining facility, 2:55903
RADIOACTIVE WASTE PROCESSING/RISK ASSESSMENT
Risk comparison of alternatives of the back end of the fuel cycle at a pre-project stage, 2:55946
RADIOACTIVE WASTE PROCESSING/SOLIDIFICATION
Immobilization of tritiated aqueous waste in polymer-inpregnated concrete, 2:55905
Management and storage of commercial power reactor wastes, 2:55899 (ERDA-76-162)
RADIOACTIVE WASTE PROCESSING/TRANSMUTATION
Linear accelerator fission product transmuter (LAFPT), 2:55906
Report of the workshop on the technological implications of burning actinides to the fuel cycle, 2:55898 (CONF-770354-1)
RADIOACTIVE WASTE STORAGE/CONTAINERS
Elastic solutions for selected circular-symmetric problems as applied to the design of the waste-container sleeve. Technical memorandum report RSI-0007, 2:55909 (ORNL/SUB-3706/4)
Thermo/viscoelastic analysis of the waste-container sleeve: I. Time-dependent salt loading on the sleeve and closure of the drillhole. Technical memorandum report RSI-0020, 2:55913 (ORNL/SUB-4269/4)
Thermoelastic analysis of waste-container sleeve: I. Initial estimates of loading on the sleeve. Technical memorandum report (RSI-0010), 2:55910 (ORNL/SUB-3706/6)
Thermoelastic/plastic analysis of waste-container sleeve: III. Influence of salt strength on sleeve loading. Technical memorandum report (RSI-0018), 2:55911 (ORNL/SUB-4269/2)
Thermoelastic/plastic analysis of waste-container sleeve: IV. Air gap influence on hole closure. Technical memorandum report (RSI-0019), 2:55912 (ORNL/SUB-4269/3)
RADIOACTIVE WASTE STORAGE/PILOT PLANTS
Waste Isolation Pilot Plant (WIPP) conceptual design report. Part I: executive summary. Part II: facilities and system, 2:55915 (SAND-77-0274)
RADIOACTIVE WASTE STORAGE/UNDERGROUND STORAGE
Analysis and evaluation of the rock mechanics aspects of the proposed salt mine repository. Summary progress report RSI-0005, 2:55908 (ORNL/SUB-3706/2)
Data input manual for RSI/TRANCO: a finite element heat conduction computer program (Rock mechanics for waste terminal storage), 2:57475 (Y/OWI/SUB-77/22303/1)
Geologic feasibility of talc and serpentinite bodies from the Appalachian Mountain region of eastern United States with regard to siting of radioactive-waste repositories. Part I. Additional conclusions relating to ultramafic rocks. Part II. Field investigations of talc and serpentinite deposits. Supplementary report, 2:55918 (Y/OWI/SUB-4496/2)
RADIOACTIVE WASTES
See also RADIOACTIVE EFFLUENTS
RADIOACTIVE WASTES/HEAT TRANSFER
Conduction of heat in a cylindrical homogeneous medium with a moving source, 2:55907
Natural convection in porous media with heat generation, 2:56801
RADIOACTIVE WASTES/LEACHING
Calculations of radioactivity release due to leaching of vitrified high-level waste, 2:55922
Leaching of solidified radioactive waste, 2:55921
RADIOACTIVE WASTES/RADIATION HAZARDS
Relative hazard of nuclear wastes and naturally occurring toxic minerals, 2:55952
RADIOACTIVE WASTES/TRANSPORT
Transportation status and problems in the back end of the fuel cycle, 2:55889
RADIOACTIVE WASTES/WASTE TRANSPORTATION
Preliminary risk analysis of the transportation of nuclear waste, 2:55948
Risk analysis of the road transport of radioactive waste in the Netherlands, 2:55950
Transportation of vitrified high-level radioactive waste by rail: fault tree analysis and accidental release, 2:55949
RADIOACTIVITY
See also NATURAL RADIOACTIVITY
RADIOACTIVITY/ENVIRONMENTAL TRANSPORT
AEOLUS: atmospheric dispersion and finite-cloud doses during normal, sea-breeze, and accident conditions, 2:57372
Probabilistic prediction of X/Q for routine intermittent gaseous releases, 2:57373
RADIOACTIVITY/MONITORING
Radiation levels in the vicinity of ERDA facilities, 2:57370
RADIOACTIVITY TRANSPORT
Radioactive corrosion product transport and control (LMFBR), 2:56511 (CONF-760503-P1)
RADIOACTIVITY TRANSPORT/CALCULATION METHODS
Computational technique for estimating corrosion product release in an LMFBR, 2:56513 (CONF-760503-P1)
RADIOACTIVITY TRANSPORT/SIMULATION
Radiochemical measurement of mass transport in sodium (LMFBR), 2:56516 (CONF-760503-P1)
RADIOBIOLOGICAL EFFECTS
See BIOLOGICAL RADIATION EFFECTS
RADIOCARBON DATING
See CARBON 14
RADIODIAGNOSIS (RADIONUCLIDES)
See NUCLEAR MEDICINE
RADIOISOTOPE HEAT SOURCES/RESEARCH PROGRAMS
^{238}Pu fuel form processes. Savannah River Laboratory monthly report, June 1977, 2:55974 (DPST-77-128-6)
Heat source component development program. Quarterly report for April-June 1977, 2:55973 (BMI-X-683)
RADIOISOTOPE HEAT SOURCES/SAFETY
Functional and structural performances of radioisotope power sources for artificial heart, 2:55972
RADIOISOTOPE MIGRATION
See RADIONUCLIDE MIGRATION
RADIOISOTOPES
See also NEUTRON-RICH ISOTOPES
RADIOISOTOPES/ENVIRONMENTAL TRANSPORT
Operators guide: Atmospheric Release Advisory Capability (ARAC) site facility, 2:57368 (UCID-17490)
RADIOISOTOPES/GAMMA RADIATION
Al-26: a galactic source of gamma ray line emission (List of candidates for gamma emission), 2:57485 (N-77-16980)
RADIONUCLIDE CONCENTRATION
See RADIOACTIVITY
RADIONUCLIDE MIGRATION
(In environment.)
RADIONUCLIDE MIGRATION/COMPUTER CODES
Finite element models for sediment and contaminant transport in surface waters. Transport of sediments and radionuclides in the Clinch River (^{137}Cs, ^{90}Sr, ^{198}Au), 2:57398 (BNWL-2227)
RADIONUCLIDES
See RADIOISOTOPES
RADIUM 226/RADIOECOLOGICAL CONCENTRATION
Concentrations of radionuclides and selected stable elements in fruits and vegetables, 2:57381 (CONF-770676-1)
RADIUM 226/SAFETY STANDARDS
Regulation of naturally occurring and accelerator-produced radioactive materials. A Task Force review, 2:57430 (NUREG-0301)
RADON/ENVIRONMENTAL IMPACTS
Radon emanation in geothermal steam, 2:56196
RAIL TRANSPORT/ECONOMICS
Western coal transportation: unit trains or slurry pipelines. Final report, 2:57025 (PB-264916)
RAILWAYS
See also ELECTRIC RAILWAYS
RAILWAYS/DC SYSTEMS
Technical feasibility study of railroad electrification with high voltage (10-50 kV) direct current. Final report, Jan-Jun 1976, 2:57065 (PB-265018)
RAIN/SIMULATION
Rainfall simulation for environmental application, 2:57351 (ORNL-5151)
RANCHO SECO-1 REACTOR/ENVIRONMENTAL IMPACTS
Lidar observations of plume diffusion at Rancho Seco Generating Station, 2:57364
RANCHO SECO-2 REACTOR/ENVIRONMENTAL IMPACTS
Lidar observations of plume diffusion at Rancho Seco Generating Station, 2:57364
RANGER DEPOSIT/EXPLOITATION
Ranger uranium environmental enquiry. Final submission by the Australian Atomic Energy Commission, 2:55934 (INIS-mf-3272)
RAPSODIE REACTOR/COOLANT CLEANUP SYSTEMS
Evolution of sodium purification: RAPSODIE, PHENIX, SUPER-PHENIX, 2:56484 (CONF-760503-P1)

RAPSODIE REACTOR/REACTOR OPERATION
Some aspects of sodium technology issued from the operating experience of RAPSODIE and PHENIX, 2:56478 (CONF-760503-P1)
RARE EARTH COMPOUNDS/ENTROPY
Standard state entropies of the aqueous rare earth ions, 2:57214
RATS/HYPERTENSION
Genetic influence on hypertension induced by cadmium in Dahl hypertension-resistant and hypertension-sensitive rats, 2:57427
REACTIVITY INSERTIONS
See also ROD EJECTION ACCIDENTS
REACTIVITY INSERTIONS/SIMULATION
Generator of reactivity functions, 2:56640
REACTOR ACCIDENTS
See also EXCURSIONS
FUEL ELEMENT FAILURE
LOSS OF COOLANT
LOSS OF FLOW
MELTDOWN
REACTOR CORE DISRUPTION
ROD EJECTION ACCIDENTS
Aerosol attenuation in leakage paths (LMFBR accident analysis), 2:56819
Comparison of experimental data with COBRA-3M prediction for an LMFBR loss-of-piping-integrity transient, 2:56856
Effect of humidity on the burning rate of sodium droplets, 2:56823
Hydrogen jet recombination under postulated LMFBR accident contitions, 2:56837
Selecting probability for use in direction-dependent accident dispersion models consistent with past NRC practice, 2:56858
Sensitivity of radiological consequences to variations in aerosol parameters (LMFBR accident analysis), 2:56820
REACTOR ACCIDENTS/FISSION PRODUCT RELEASE
Evaluation of integral experiments and potential test facilities for future HTGR fission product safety research, 2:56775 (GA-A-14205)
REACTOR ACCIDENTS/FUEL-COOLANT INTERACTIONS
Correlation for the Leidenfrost temperature for spherical particles and its application to FCI analysis, 2:56857
REACTOR ACCIDENTS/MATHEMATICAL MODELS
Unified model for fission gas release and sodium boiling in reactor coolant channel, 2:56826
REACTOR ACCIDENTS/REACTOR KINETICS
Comparison of 2D and 3D diffusion theory codes for transition-phase modeling of distorted subassemblies (LMFBR), 2:56778 (HEDL-TME-77-26)
REACTOR COMPONENTS
See also BREEDING BLANKETS
CONTROL ELEMENTS
FUEL ELEMENTS
REACTOR COOLING SYSTEMS
REACTOR CORES
REACTOR COMPONENTS/COATINGS
Corrosion and tribological investigations of chromium carbide coatings for sodium cooled reactor applications, 2:56494 (CONF-760503-P1)
REACTOR COMPONENTS/FABRICATION
Manufacture of heavy reactor components with particular consideration to quality assurance, 2:56678
REACTOR COMPONENTS/FAULT TREE ANALYSIS
Decision-table development for use with the CAT code for the automated fault-tree construction, 2:56790 (PB-265098)
REACTOR COMPONENTS/FRICTION
Corrosion and tribological investigations of chromium carbide coatings for sodium cooled reactor applications, 2:56494 (CONF-760503-P1)
Development of low friction materials for LMFBR components, 2:56492 (CONF-760503-P1)
Friction and wear in liquid-metal systems: comparability problems of test results obtained from different test facilities (LMFBR), 2:56493 (CONF-760503-P1)
REACTOR COMPONENTS/QUALITY ASSURANCE
Manufacture of heavy reactor components with particular consideration to quality assurance, 2:56678
REACTOR COMPONENTS/RELIABILITY
Automatic event tree construction, 2:56865
DICOMICS-TWIN: self-adaptive algorithm for minimal cut sets determination from fault trees, 2:56866
Modular approach to fault tree and reliability analysis, 2:56867
Systems approach to structural reliability assurance, 2:56670
Theoretical fundamentals for the SAFTL and CRESS program system to calculate system reliability, 2:56877 (NP-tr-1977)
REACTOR COMPONENTS/SEISMIC EFFECTS
Determination of equivalent response cycles for use in earthquake-induced fatigue analyses, 2:56793 (SAN/1011-106)
REACTOR COMPONENTS/STRESS ANALYSIS
Basic formulation and a computer program for inelastic large deformation analysis (COMPOSITE-III code), 2:56669
REACTOR COMPONENTS/WEAR
Friction and wear in liquid-metal systems: comparability problems of test results obtained from different test facilities (LMFBR), 2:56493 (CONF-760503-P1)
REACTOR COMPONENTS/WELDED JOINTS
Assessment of toughness and cracking in the heat-affected zone of light water reactor components, 2:56386
Pressure containing welds in nuclear power systems : meeting the special requirements, 2:56685
REACTOR CONTROL RODS
See CONTROL ELEMENTS
REACTOR CONTROL SYSTEMS
(The processes and operations ensuring the control and safe running of a nuclear reactor.)
REACTOR CONTROL SYSTEMS/DESIGN
Activities of the committee 'Kernreaktorregelung' (nuclear reactor control) in the past few years and future projects, 2:56734
Reactor capacity-control technique. Development of KWU/PWR's during the past 10 years and development tendencies, 2:56733
Reactor control system (Patent), 2:56736
REACTOR CONTROL SYSTEMS/ELECTRONIC EQUIPMENT
Safe operation of power plants. Pt. 1. State of technology concerning electrotechnical and control equipment in thermal power plants, 2:56728
Safe operation of power plants. Pt. 2 . Technical means for the optimal operation of nuclear power plants, 2:56729
REACTOR CONTROL SYSTEMS/SEISMIC EFFECTS
Instrumentation qualification. Seismic qualification of C-E instrumentation equipment. Part One, 2:56769 (CENPD-182(Pt.1))
Instrumentation qualification. Seismic qualification of C-E instrumentation equipment. Part Two, 2:56770 (CENPD-182(Pt.2))
REACTOR CONTROL THEORY
See REACTOR KINETICS
REACTOR COOLING SYSTEMS
See also DIRECT CYCLE COOLING SYSTEMS
PRIMARY COOLANT CIRCUITS
REACTOR COOLING SYSTEMS/CONTROL EQUIPMENT
Output control system in a boiling water atomic power plant (Patent), 2:56737
REACTOR COOLING SYSTEMS/COOLANT CLEANUP SYSTEMS
Sodium and cover gas chemistry in the high temperature sodium facility (LMFBR), 2:56489 (CONF-760503-P1)
REACTOR COOLING SYSTEMS/CORROSION
Material effects in LMFBR sodium systems, 2:56517 (CONF-760503-P1)
Metallurgical problems associated with large sodium loop operations (LMFBR), 2:56485 (CONF-760503-P1)
Operational techniques employed for the liquid sodium source term control loops (LMFBR), 2:56491 (CONF-760503-P1)
REACTOR COOLING SYSTEMS/CORROSION PRODUCTS
Behavior of active products of corrosion in the system of a channel-type boiling-water nuclear power reactor of a single-loop nuclear power plant, 2:56379
REACTOR COOLING SYSTEMS/CORROSION PROTECTION
Usefulness and methods of periodic treatment of extrareactor part of single-loop nuclear power plants, 2:56682
REACTOR COOLING SYSTEMS/FLOW REGULATORS
Device for increasing fluid resistance in a core vessel cooling system (Patent), 2:56704
REACTOR COOLING SYSTEMS/LEAK DETECTORS
Leakage detecting apparatus in an atomic power plant (Patent), 2:56703
REACTOR COOLING SYSTEMS/LEVEL INDICATORS
Method of detecting and correcting reactor water level (Patent; BWR), 2:56406
REACTOR COOLING SYSTEMS/MAINTENANCE
Usefulness and methods of periodic treatment of extrareactor part of single-loop nuclear power plants, 2:56682
REACTOR COOLING SYSTEMS/OPERATION
Materials experience with large sodium loops and components (LMFBR), 2:56486 (CONF-760503-P1)
REACTOR COOLING SYSTEMS/PIPES
Surface flaw in a pressurised and thermally-shocked hollow cylinder, 2:56658
REACTOR COOLING SYSTEMS/RADIOACTIVITY TRANSPORT
Computational technique for estimating corrosion product release in an LMFBR, 2:56513 (CONF-760503-P1)
Operational techniques employed for the liquid sodium source term control loops (LMFBR), 2:56491 (CONF-760503-P1)
Radioactive corrosion product transport and control (LMFBR), 2:56511 (CONF-760503-P1)

Radiochemical measurement of mass transport in sodium (LMFBR), 2:56516 (CONF-760503-P1)
REACTOR COOLING SYSTEMS/SEISMIC EFFECTS
Some probabilistic aspects of the seismic risk of nuclear reactors, 2:56789 (PB-265020)
REACTOR COOLING SYSTEMS/TEST FACILITIES
Operational techniques employed for the liquid sodium source term control loops (LMFBR), 2:56491 (CONF-760503-P1)
Sodium characterization during the starting period of a sodium loop (LMFBR), 2:56490 (CONF-760503-P1)
REACTOR CORE DISRUPTION
Alternative accident scenario for LMFBR core disruption, 2:56830
Dynamics of large waves during molten cladding film relocation (LMFBR), 2:56852
Evaporation kinetics of oxide fuels and their effect on the actinide redistribution in reactor fuel pins and on fuel vapor pressure under accident conditions, 2:56878 (EURFNR-1370)
Importance of the solification of fuel condensate (LMFBR), 2:56851
Proposed model for vapor bubble-slug heat transfer during LMFBR HCDAs, 2:56846
Vapor pressure equation-of-state in core disassmbly calculations, 2:56848
REACTOR CORE DISRUPTION/FISSION PRODUCT RELEASE
Aerosol measurements and modeling for fast reactor safety. Task 7. Quarterly progress report, October 1-December 31, 1976 (LMFBR; time dependent aerosol suspension behavior), 2:56768 (BMI-NUREG-1969)
Radiological assessment models. Tenth quarterly report, December 1976-February 1977, 2:56777 (GEFR-14034-10)
REACTOR CORE DISRUPTION/POOL BOILING
Boiling pool analysis during transition to the transition phase of core disruptive accidents in LMFBRs, 2:56844
REACTOR CORE DISRUPTION/RADIANT HEAT TRANSFER
Attenuation of radiological consequences from CDA's by radiation. Progress report, October 1, 1976-September 31, 1977, 2:56772 (COO-4040-1)
REACTOR CORE DISRUPTION/RADIOACTIVE AEROSOLS
Effect of radiative cooling on HCDA radiological consequences during buoyancy period, 2:56822
First-generation model to predict particle-size distributions for condensed UO_2 vapor, 2:56821
REACTOR CORE DISRUPTION/THERMODYNAMICS
Evaporation studies of liquid oxide fuel at very high temperatures using laser beam heating (LMFBR; UO_2), 2:56774 (EURFNR-1400)
REACTOR CORES/DESIGN
Core construction in a pressure tube type heavy water reactor (Patent), 2:56472
Operational reliability evaluation of fast power reactor cores, 2:56569
Pressure tube reactor (Patent), 2:56471
REACTOR CORES/EXCURSIONS
Effect of solid fission products and dislocations on swelling and fission gas release in oxides during a fast overpower transient, 2:56800
REACTOR CORES/FLOW BLOCKAGE
Detection of a partial blockage in a heterogeneous core (LMFBR), 2:56476 (ANL-CT-77-30)
REACTOR CORES/HEAT TRANSFER
Method to calculate the influence of gas bubbles in liquid-metal cooled reactors, 2:56561
THECA: a code system for 3-D thermohydraulic layout of fast reactors (LMFBR), 2:56537 (EURFNR-1437)
REACTOR CORES/HYDRAULICS
Method to calculate the influence of gas bubbles in liquid-metal cooled reactors, 2:56561
THECA: a code system for 3-D thermohydraulic layout of fast reactors (LMFBR), 2:56537 (EURFNR-1437)
REACTOR CORES/ORIFICES
Optimized method for orificing LMFBR cores, 2:56530 (CONF-770611-6)
REACTOR CORES/RADIOACTIVITY TRANSPORT
Behaviour of tritium in a graphite reactor, 2:56441
REACTOR CORES/REACTOR INSTRUMENTATION
Detection of a partial blockage in a heterogeneous core (LMFBR), 2:56476 (ANL-CT-77-30)
REACTOR CORES/SUPPORTS
Feasibility of monitoring the strength of HTGR core support graphite: Part I, 2:56427 (BNWL-2239)
REACTOR CORES/TRANSIENTS
Equation-of-state and nonequilibrium bubble behavior during fast transients, 2:56799
REACTOR FUEL ELEMENTS
See FUEL ELEMENTS
REACTOR FUELS
See NUCLEAR FUELS
REACTOR INSTRUMENTATION/LI-DRIFTED GE DETECTORS
Ge(Li) system for the monitoring of low level radioactive gases, 2:57332
REACTOR INSTRUMENTATION/PERFORMANCE TESTING
Detection of a partial blockage in a heterogeneous core (LMFBR), 2:56476 (ANL-CT-77-30)
REACTOR INSTRUMENTATION/SEISMIC EFFECTS
Instrumentation qualification. Seismic qualification of C-E instrumentation equipment. Part One, 2:56769 (CENPD-182(Pt.1))
Instrumentation qualification. Seismic qualification of C-E instrumentation equipment. Part Two, 2:56770 (CENPD-182(Pt.2))
REACTOR INTERNALS/MECHANICAL VIBRATIONS
Neutron noise analysis as a diagnostic method of mechanical vibrations in WWER type reactor core components, 2:56425
REACTOR INTERNALS/SURFACE TREATMENTS
Core components for a sodium cooling fast breeder (Patent), 2:56578
REACTOR KINETICS/DISCRETE ORDINATE METHOD
Exponential supplementary equations for S/sub N/ methods: the one-dimensional case, 2:56642
REACTOR KINETICS/FINITE ELEMENT METHOD
Solution of the finite element diffusion and P_1 equations by iteration, 2:56641
REACTOR KINETICS/NEUTRON FLUX
Discrete neutron decay constants above the Corngcld limit for infinite slabs, 2:56645
REACTOR KINETICS/NEUTRON TRANSPORT THEORY
Solution of the finite element diffusion and P_1 equations by iteration, 2:56641
REACTOR KINETICS/NUCLEATE BOILING
Improved nucleate boiling design equation, 2:56648
REACTOR KINETICS/RESPONSE MATRIX METHOD
Improved response matrix method and its verification by one-dimensional analysis on fast reactors, 2:56650
REACTOR KINETICS/WIGNER THEORY
Wigner-type continuous slowing down theory for the fast-neutron spectrum, 2:56644
REACTOR LATTICES/FISSION FOIL DETECTORS
Monte Carlo calculations of cadmium cutoff energies and an ansatz formula, 2:56759
REACTOR LATTICES/NEUTRON SPECTRA
Measurement of space dependent angular thermal neutron spectra in natural uranium-light water slab, 2:56649
REACTOR LICENSING
Environmental planning and the siting of nuclear facilities: the integration of water, air, coastal, and comprehensive planning into the nuclear siting process. Improving regulatory effectiveness in federal/state siting actions, 2:56582 (NUREG-0199)
Nuclear power plant licensing: opportunities for improvement, 2:56583 (NUREG-0292)
Power Reactor Docket Information, 2:56584 (NUREG/PRDI-77/4)
REACTOR MATERIALS
(See also specific materials.)
See also NUCLEAR FUELS
Isotopically tailored materials for fission and fusion reactors, 2:56652 (MLM-2426(OP))
REACTOR MATERIALS/CARBURIZATION
Materials for advanced high temperature reactors, 2:57139
REACTOR MATERIALS/COATINGS
Development of low friction materials for LMFBR components, 2:56492 (CONF-760503-P1)
REACTOR MATERIALS/COMPATIBILITY
Compatibility of structural materials with boiling potassium (LMFBR), 2:56528 (CONF-760503-P1)
Material effects in LMFBR sodium systems, 2:56517 (CONF-760503-P1)
REACTOR MATERIALS/CORROSION
Compatibility of structural materials with boiling potassium (LMFBR), 2:56528 (CONF-760503-P1)
Corrosion, transport, and deposition of stainless steel in liquid sodium (LMFBR; SS-316), 2:56522 (CONF-760503-P1)
Corrosion of steels in liquid sodium (LMFBR), 2:56525 (CONF-760503-P1)
Corrosion and creep of pressurized stainless-steel tubes in liquid sodium at 873 and 973°K, 2:56542
High temperature materials requirements in reforming of gaseous hydrocarbons with HTR heat, 2:56613
Sodium environment effects to structural materials for fast reactors, 2:56540 (PNC-J-225-76-02)
Solubility of oxygen in liquid sodium: effect on interpretation of corrosion data (LMFBR), 2:56527 (CONF-760503-P1)
Thermodynamic and diffusion studies on corrosion of austenitic stainless steel in liquid sodium (LMFBR), 2:56526 (CONF-760503-P1)

REACTOR MATERIALS/CREEP
Corrosion and creep of pressurized stainless-steel tubes in liquid sodium at 873 and 973°K, 2:56542
Efficient finite element method for nonlinear structural mechanics and its application to transient creep analysis, 2:56690
Materials for advanced high temperature reactors, 2:57139
REACTOR MATERIALS/FATIGUE
Cyclic stress strain behavior of four nuclear pressure vessel materials, 2:56676
Low cycle fatigue testing in flowing sodium at elevated temperatures (LMFBR), 2:56521 (CONF-760503-P1)
REACTOR MATERIALS/FRICTION
Evaluation of cobalt and nickel base materials for sliding and static contact applications in a liquid metal fast breeder reactor, 2:56498 (CONF-760503-P1)
Friction and wear behavior of Colmonoy and Stellite alloys in sodium environment (LMFBR), 2:56496 (CONF-760503-P1)
Investigations into the self-welding behavior of metallic materials exposed to sodium (LMFBR; Inconel 718; Stellite), 2:56499 (CONF-760503-P1)
REACTOR MATERIALS/OXIDATION
Materials for advanced high temperature reactors, 2:57139
REACTOR MATERIALS/PHYSICAL RADIATION EFFECTS
Microstructure, deformation, and fracture behavior of reactor core materials, 2:56653
Simulation of void swelling: a critical review, 2:56654
Systematic approach to the radiation damage problem in fission and fusion reactor structural alloys, 2:57143 (UWFDM-184)
REACTOR MATERIALS/WEAR
Friction and wear behavior of Colmonoy and Stellite alloys in sodium environment (LMFBR), 2:56496 (CONF-760503-P1)
REACTOR OPERATION
Nuclear power plants 1976 - international VGB congress at Stuttgart, September 7 to 10, 1976, 2:56366
REACTOR OPERATION/DATA
Nuclear power plant operating experience, 1974-1975, 2:56586 (PB-265794)
REACTOR OPERATION/DATA ANALYSIS
Advanced methodology and systems for power plant pathology, 2:56595
REACTOR OPERATION/DATA PROCESSING
Advanced methodology and systems for power plant pathology, 2:56595
REACTOR OPERATION/MONITORING
Experience in diagnostic and surveillance methods development, 2:56363
Power plant surveillance and diagnostics research and development needs, 2:56364
REACTOR PROTECTION SYSTEMS
Risk assessment to determine the advisability of seismic trip systems, 2:56863
REACTOR PROTECTION SYSTEMS/DESIGN
Positive safety system with control relay and current regulation functions (Patent), 2:56738
Positive safety control system (Patent), 2:56739
REACTOR PROTECTION SYSTEMS/RELIABILITY
Bayesian Zero-Failure (BAZE) reliability demonstration testing procedure for components of nuclear reactor safety systems, 2:56784 (LA-6813-MS)
REACTOR SAFETY
(Theoretical and experimental investigations of the behavior of reactor types and designs under various real or hypothetical accidents.)
Data and assessment of human factor impact on nuclear reactors, 2:56860
Evaluation of human errors in commercial light-water reactors, 2:56859
How safe, 2:56870
Natural convection in porous media with heat generation (LMFBR), 2:56801
Steam-water mixing and system hydrodynamics program. Task 4. Quarterly progress report, October-December 1976 (PWR), 2:56767 (BMI-NUREG-1968)
REACTOR SAFETY/BIBLIOGRAPHIES
Bibliography of reports on research sponsored by the NRC Office of Nuclear Regulatory Research, July-December 1976, 2:56786 (ORNL/NUREG/NSIC-135)
REACTOR SAFETY/RESEARCH PROGRAMS
Bibliography of reports on research sponsored by the NRC Office of Nuclear Regulatory Research, July-December 1976, 2:56786 (ORNL/NUREG/NSIC-135)
Reports on the research projects in the field of reactor safety sponsored by the Federal Ministry of Science and Technology. Period under report: July 1st to September 30th, 1976 (German Federal Republic), 2:56779 (IRS-F-33)
REACTOR SITES
Perryman Nuclear Power Plant. Site suitability--site safety report, volume I: chapters-sections 1.1, 1.2, 1.4, 1.6; 2.1, 2.2, 2:56581 (DOCKET-50586-1)
REACTOR SITES/POPULATION DYNAMICS
Guidelines for estimating present and forecasting future population distributions surrounding power reactor sites. (Draft of a standard) (USA), 2:56743 (EPRI-EA-427-SR)
REACTOR SITES/RECOMMENDATIONS
Data for the evaluation of the properties of sites for nuclear power plants in consideration of reactor safety and radiation protection (German Federal Republic), 2:56749 (NP-tr-1974)
REACTOR SITING
See SITE SELECTION
REACTOR TECHNOLOGY/TECHNOLOGY TRANSFER
Experience in transfer of nuclear technology, 2:56632
Experience in transfer of nuclear technology, 2:56635
IAEA experience in the transfer of nuclear technology, 2:56631
Nuclear technology experience acquired by Argentina, 2:56636
Technology transfer: its contribution to the Canadian nuclear industry, 2:56633
Transactions of the Iran conference on the transfer of nuclear technology held April 10-14, 1977, in Persepolis/Shiraz, Iran, 2:56630
Transfer of technology in the French-Iranian study for a nuclear research center in Iran, 2:56637
U.S. experience in the transfer of nuclear technology, 2:56634
REACTOR VESSELS/STRESS ANALYSIS
Inelastic behavior of finite circular cylindrical shells, 2:56554
REACTORS
See also BREEDER REACTORS
GAS COOLED REACTORS
HEAVY WATER MODERATED REACTORS
IRRADIATION REACTORS
MOLTEN SALT REACTORS
POWER REACTORS
PRODUCTION REACTORS
RESEARCH AND TEST REACTORS
THERMAL REACTORS
WATER COOLED REACTORS
REACTORS/MEETINGS
Transactions of the American Nuclear Society 1977 annual meeting, New York, NY, June 12-16, 1977, 2:57804
RECORDS RETRIEVAL
See INFORMATION RETRIEVAL
RECYCLE (FUEL)
See FUEL CYCLE
RECYCLING/FINANCIAL INCENTIVES
Impact of the Federal tax code on resource recovery. Final report (Effect of tax-subsidy elimination), 2:56929 (PB-264886)
RECYCLING (FUEL)
See REPROCESSING
REDOX FUEL CELLS/ELECTROCHEMISTRY
Factors affecting the open-circuit voltage and electrode kinetics of some iron/titanium redox flow cells, 2:57000 (ERDA/NASA/1002-77/10)
REDOX FUEL CELLS/PERFORMANCE
Factors affecting the open-circuit voltage and electrode kinetics of some iron/titanium redox flow cells, 2:57000 (ERDA/NASA/1002-77/10)
REFERENCE MAN/INTEGRAL DOSES
Current methods of internal dose estimation, 2:57429 (NIRS-M-10)
REFERENCE THETA PINCH REACTOR/FIRST WALL
First wall thermal-mechanical analyses of the reference theta-pinch reactor, 2:57719
REFLECTORS (NEUTRON)
See NEUTRON REFLECTORS
REFRACTORIES/CHEMICAL PROPERTIES
Chemical and physical stability of refractories for use in coal gasification. First annual progress report, May 1, 1976-April 30, 1977, 2:55565 (COO-2904-4)
REFRACTORIES/CHEMICAL REACTIONS
Chemical and physical stability of refractories for use in coal gasification. First annual progress report, May 1, 1976-April 30, 1977, 2:55565 (COO-2904-4)
REFRACTORIES/CORROSION RESISTANCE
Chemical and physical stability of refractories for use in coal gasification. First annual progress report, May 1, 1976-April 30, 1977, 2:55565 (COO-2904-4)
REFRACTORIES/HEAT TRANSFER
Study of heat transfer through refractory lined gasifier vessel walls. Quarterly progress report, December 1976-February 1977, 2:55573 (FE-2210-12)
REFRACTORIES/PHYSICAL PROPERTIES
Chemical and physical stability of refractories for use in coal gasification. First annual progress report, May 1, 1976-April 30, 1977, 2:55565 (COO-2904-4)
REFRIGERATORS/ENERGY CONSERVATION
Direct cooling refrigerator-freezers, 2:57017
REFRIGERATORS/HEAT SINKS
Fusible heat sink for a cryogenic refrigerator, 2:57265 (AD-D-003515)

REFUELING WATER SYSTEMS
See AUXILIARY WATER SYSTEMS
REFUSE
See SOLID WASTES
REGIONAL ANALYSIS/ENERGY MODELS
Regional reference energy systems (Projection to year 2000), 2:56948 (EPRI-EA-462)
REGOLITH
See OVERBURDEN
REINFORCED CONCRETE/MECHANICAL PROPERTIES
Modern materials for underground support, 2:55689
REMOTE HANDLING EQUIPMENT
Dry spent fuel cask handling system, 2:56655
REMOTE HANDLING EQUIPMENT/MAINTENANCE
Remote maintenance equipment for the new waste calcining facility, 2:55903
RENEWABLE ENERGY SOURCES/PLANNING
Proceedings of the public meeting to review the status of the inexhaustible energy resources study, 2:56985 (CONF-770560-)
RENEWABLE ENERGY SOURCES/REVIEWS
Proceedings of the public meeting to review the status of the inexhaustible energy resources study, 2:56985 (CONF-770560-)
REPROCESSING/ENVIRONMENTAL IMPACTS
Light water reactor fuel reprocessing and recycling, 2:55933 (ERDA-77-75)
RESEARCH AND TEST REACTORS/TABLES
Nuclear reactors built, being built, or planned in the United States as of June 30, 1977, 2:56362 (TID-8200-R36)
RESEARCH PROGRAMS/COST BENEFIT ANALYSIS
Overview of technological-economic models for energy policy analysis, 2:56954 (BNL-22730)
RESERVOIR ROCK/ROCK-FLUID INTERACTIONS
Rock-fluid relationship studies on the Windfall D-3A reservoir and their application in evaluatiang gas cycling effectiveness, 2:55744
RESERVOIRS (WATER)
See WATER RESERVOIRS
RESIDENTIAL SECTOR/ENERGY CONSERVATION
Energy savings via behavioral changes, 2:56947
RESIDENTIAL SECTOR/ENERGY CONSUMPTION
Planner's handbook on energy (with emphasis on residential uses), 2:57001 (NP-21852)
Report from Berkeley (Summary of 1975 summer study at LBL on Efficient Use of Energy in Buildings), 2:56946
RESIDENTIAL SECTOR/ENERGY DEMAND
International comparisons of the residential demand for energy: a preliminary analysis (World Oil Project), 2:56952 (PB-265108)
RESIDENTIAL SECTOR/FUEL CONSUMPTION
The costs of cold weather and the conservation of residential heating gas. Staff report (Cost-effective investments for each state), 2:57015 (PB-264759)
RESIDUAL FUELS/CONVERSION
Steam treatment of sulfur-containing heavy crude oil or oil residue with a combination catalyst comprising a hydrogenation-desulfurization catalyst and an overbased jet fuel containing an alkaline earth or alkali metal alkyl phenol complex (Patent), 2:55768
RESIDUES (RADIOACTIVE)
See RADIOACTIVE WASTES
RESISTORS/NOISE
Study of low-frequency excess noise in hybrid thick-film resistors, 2:57315 (ORNL/Sub-3961/2)
RESONANCE PARTICLES
See also BARYON RESONANCES
RESONANCE PARTICLES/MASS FORMULAE
Three-body mechanism for narrow resonances, 2:57578
RESONANCE PARTICLES/THREE-BODY PROBLEM
Three-body mechanism for narrow resonances, 2:57578
RESONANCE SCATTERING/REVIEWS
Decaying states, 2:57619
RESOURCE CONSERVATION
Biological productivity of renewable resources used as industrial materials, 2:56926 (PB-264457)
European waste-to-energy systems: case study of Koersor, Denmark, 2:56980 (CONS/2103-3)
European waste-to-energy systems. Case study of Munich: Munich North IA and IB, Munich North II, Munich South IV and V, 2:56981 (CONS/2103-4)
European waste-to-energy systems: case study of Geneva-Cheneviers (Switzerland), 2:56987 (CONS/2103-2)
Fibers as renewable resources for industrial materials (Review and assessment), 2:56928 (PB-264561)
Recycling waste (Book), 2:56925
Reference materials system: a source for renewable materials assessment, 2:56927 (PB-264494)
RESOURCE CONSERVATION/FINANCIAL INCENTIVES
Impact of the Federal tax code on resource recovery. Final report (Effect of tax-subsidy elimination), 2:56929 (PB-264886)
RESOURCES
See also MINERAL RESOURCES
Fibers as renewable resources for industrial materials (Review and assessment), 2:56928 (PB-264561)
RESOURCES/EVALUATION
Reference materials system: a source for renewable materials assessment, 2:56927 (PB-264494)
RESOURCES/FORECASTING
Biological productivity of renewable resources used as industrial materials, 2:56926 (PB-264457)
RHENIUM 185 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
RHENIUM 187 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
RHO-765 RESONANCES/PARTICLE PRODUCTION
Investigation of rho^0- and ω-meson production in π^-p interactions at 40 GeV/c, 2:57571
RHODIUM COMPLEXES/CRYSTAL STRUCTURE
Novel co-ordination of sulphur dioxide. The crystal and molecular structure of nitrosyl(sulfur dioxide)bis(triphenylphosphine)rhodium, 2:57233
RHODIUM COMPLEXES/SYNTHESIS
Novel co-ordination of sulphur dioxide. The crystal and molecular structure of nitrosyl(sulfur dioxide)bis(triphenylphosphine)rhodium, 2:57233
RICHLAND FFTF REACTOR
See FFTF REACTOR
RINGS/DESIGN
Investigation of the effect of the design and number of piston rings on lubricant burn-up waste, 2:57057
RIO GRANDE RIFT/HEAT FLOW
Terrestrial heat flow along the Rio Grande rift, New Mexico and southern Colorado, 2:56177 (PB-265038)
RISER CRACKING
See COAL LIQUEFACTION
RIVERS
See also STREAMS
SUSQUEHANNA RIVER
RIVERS/GEOCHEMICAL SURVEYS
Boric acid content of hot springs and river waters at Owakudani Valley, Volcano Hakone, 2:56192
RIVERS/RADIONUCLIDE MIGRATION
Finite element models for sediment and contaminant transport in surface waters. Transport of sediments and radionuclides in the Clinch River (^{137}Cs, ^{90}Sr, ^{198}Au), 2:57398 (BNWL-2227)
RIVETS
See FASTENERS
ROADS/BUILDING MATERIALS
Permeability of fly ash and fly ash stabilized soils. Final report on highway research project no. 47, 2:55648 (PB-265229)
ROCK BEDS/SENSIBLE HEAT STORAGE
Gravel and liquid storage system for solar thermal power plants, 2:56156
High-temperature energy storage in native rocks, 2:56159
ROCKS
See also METAMORPHIC ROCKS
RESERVOIR ROCK
SEDIMENTARY ROCKS
ROCKS/PHYSICAL PROPERTIES
Equipment for investigation of physical properties of rocks and minerals at different high pressure intervals, 2:56212
ROCKS/POROSITY
Characterizing cinder rock with the scanning electron microscope (From in-situ retorting), 2:55834 (UCID-17492)
ROD EJECTION ACCIDENTS/MATHEMATICAL MODELS
Comparison of one- and two-dimensional models of a control rod ejection accident in the HTGR, 2:56805
RODS/MECHANICAL VIBRATIONS
Experimental assessment of the Mindlin-McNiven rod theory, 2:57120
ROOF BOLTS/COMPUTER-AIDED DESIGN
Improvement of designs of sets for preparatory workings in Moscow basin conditions, 2:55702
ROOM AND PILLAR MINING/ROCK MECHANICS
Analysis and evaluation of the rock mechanics aspects of the proposed salt mine repository. Summary progress report RSI-0005, 2:55908 (ORNL/SUB-3706/2)
Design aspects of the alpha repository: IV. Structural analysis of excavation geometries. Technical memorandum report RSI-0030, 2:55914 (ORNL/SUB-4269/11)
Elastic solutions for selected circular-symmetric problems as applied to the design of the waste-container sleeve. Technical memorandum report RSI-0007, 2:55909 (ORNL/SUB-3706/4)
Thermo/viscoelastic analysis of the waste-container sleeve: I. Time-dependent salt loading on the sleeve and closure of the drillhole. Technical memorandum report RSI-0020, 2:55913 (ORNL/SUB-4269/4)

ROTORS
See also SAVONIUS ROTORS
ROTORS/BEARINGS
Effect of rigidity and damping of bearings on the value of threshold capacity of self-exciting vibrations of steam turbine rotors, 2:56340
ROTORS/HEAT TREATMENTS
Heat treatment of large-sized welded steam turbine rotors for nuclear power plants, 2:56268
ROTORS/STABILITY
Investigation of stability of asymmetrically supported rotors, 2:56269
ROTORS/WELDED JOINTS
Investigation of the structural strength of welded and forged turbogenerator rotors, 2:56330
RUNAWAY (REACTOR ACCIDENT)
See EXCURSIONS
RUTHENIUM 106/RADIOECOLOGICAL CONCENTRATION
Concentrations of radionuclides and selected stable elements in fruits and vegetables, 2:57381 (CONF-770676-1)
RWE-BAYERNWERK REACTOR/PRESSURE VESSELS
Experimental evaluation of the fast neutron fluence for the KRB reactor pressure vessel and its operational relevance, 2:56381

S

SAFEGUARDS
See also PHYSICAL PROTECTION DEVICES
SAFEGUARDS/EVALUATION
Material control assessment procedure, 2:55966 (UCRL-79214)
SAFEGUARDS/RESEARCH PROGRAMS
Physical protection of nuclear facilities. Quarterly progress report, January-March 1977, 2:55963 (SAND-77-0999)
Progress report for the Division of Safeguards and Security: July-December 1976 (Development of nondestructive assay measurements, systems development, and applications), 2:55955 (MLM-2429)
SAFEGUARDS/SYSTEMS ANALYSIS
Safeguards system design methodology, 2:55961 (SAND-77-0890C)
SAFETY ENGINEERING
Systems engineering applications for safety models in nuclear reactors, 2:56879
SAFETY (NUCLEAR)
See RADIATION PROTECTION
SAFETY RODS
See SCRAM RODS
SALINITY/BIOLOGICAL EFFECTS
Effect of salinity on cadmium uptake by the tissues of the shore crab Carcinus maenas, 2:57451
SALT DEPOSITS/COMPRESSION STRENGTH
Thermoelastic/plastic analysis of waste-container sleeve: III. Influence of salt strength on sleeve loading. Technical memorandum report (RSI-0018), 2:55911 (ORNL/SUB-4269/2)
SALT DEPOSITS/EXCAVATION
Technical innovations in solution mining and their application in the federal Etzel cavern project, 2:55803
SALT DEPOSITS/LEACHING
Technical innovations in solution mining and their application in the federal Etzel cavern project, 2:55803
SALT DEPOSITS/ROCK MECHANICS
Requirements for salt cavity stability analysis, 2:55828
SALT DEPOSITS/SHEAR PROPERTIES
Thermoelastic/plastic analysis of waste-container sleeve: III. Influence of salt strength on sleeve loading. Technical memorandum report (RSI-0018), 2:55911 (ORNL/SUB-4269/2)
SALT DEPOSITS/STABILITY
Requirements for salt cavity stability analysis, 2:55828
SALT DEPOSITS/TENSILE PROPERTIES
Thermoelastic/plastic analysis of waste-container sleeve: III. Influence of salt strength on sleeve loading. Technical memorandum report (RSI-0018), 2:55911 (ORNL/SUB-4269/2)
SALT DEPOSITS/UNDERGROUND MINING
Technical innovations in solution mining and their application in the federal Etzel cavern project, 2:55803
SALTS/DISSOLUTION
Laboratory experiment demonstrating the way in which a steam barrier prevents the dissolution of salt buried in a flooded packed bed (Implications for preventing radionuclide migration near groundwater in underground explosions), 2:57212 (UCID-17507)
SAN FRANCISCO BAY/COMPARATIVE EVALUATIONS
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)
SAN FRANCISCO BAY/SEDIMENTS
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)
SAN FRANCISCO BAY/SURFACE WATERS
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)
SANDSTONES/POROSITY
Modelling pore structure by 2-D and 3-D networks with application to sandstones, 2:57465
SANDSTONES/STRESS ANALYSIS
Empirical relation for dilatant behavior in brittle rocks, 2:57474 (UCRL-79011)
SANDSTONES/TENSILE PROPERTIES
Empirical relation for dilatant behavior in brittle rocks, 2:57474 (UCRL-79011)
SANITARY LANDFILLS/COST BENEFIT ANALYSIS
Solid waste disposal feasibility study for Richmond County, Georgia Board of Commissioners, 2:57316 (PB-264471)
SAVANNAH RIVER PLANT/RADIOACTIVE WASTE MANAGEMENT
Integrated radioactive defense waste management plan, 2:55916 (SRO-TWM-77-1)
SAVONIUS ROTORS/AERODYNAMICS
Wind tunnel performance data for two- and three-bucket Savonius rotors, 2:56222 (SAND-76-0131)
SAVONIUS ROTORS/PERFORMANCE TESTING
Wind tunnel performance data for two- and three-bucket Savonius rotors, 2:56222 (SAND-76-0131)
SAVONIUS ROTORS/TORQUE
Wind tunnel performance data for two- and three-bucket Savonius rotors, 2:56222 (SAND-76-0131)
SBR-5 REACTOR/RADIOACTIVITY TRANSPORT
Radioactive product behavior during the operation of sodium-cooled reactors of the USSR, 2:56481 (CONF-760503-P1)
SCALING
Adsorption of metal ions on colloidal silica, 2:56210
SCHMEHAUSEN THTR REACTOR
See THTR-300 REACTOR
SCHNELLER NATRIUMGEKUEHLTER REAKTOR
See SNR-1 REACTOR
SCHOTTKY BARRIER DIODES/SEMICONDUCTOR JUNCTIONS
Analysis of silicon solar cells with stripe geometry junctions, 2:56049
SCINTIGRAPHY
See SCINTISCANNING
SCINTISCANNING
Studies of the heart with ECG-gated scintigraphy, 2:57421
SCINTISCANNING/IMAGE PROCESSING
Digital modeling of a zone plate, gamma-ray imaging system, 2:57424
Role of midi-maxi computer interaction in nuclear medicine, 2:57423
SCRAM RODS/CONTROL EQUIPMENT
Positive safety electronic control system and process (Patent), 2:56740
SCREWS
See FASTENERS
SCYLLA DEVICES/END EFFECTS
End loss from a collision dominated theta pinch plasma, 2:57630
SCYLLAC DEVICES/STABILIZATION
Feedback stabilization experiments using $l = 2$ equilibrium windings in Scyllac, 2:57661 (LA-UR-77-1142)
SEA DISPOSAL
See MARINE DISPOSAL
SEALS
See also GASKETS
SEALS/FAILURES
End face seals in high pressure water--learning from those failures, 2:56473
SEAS
See also PACIFIC OCEAN
SEAS/RADIOECOLOGY
Fundamental aspects of marine radioecology. 1, 2:57400 (NIRS-M-10)
SEAS/RADIONUCLIDE MIGRATION
Oceanic distributions of radionuclides from nuclear weapons testing, 2:55927
SEAWATER/CORROSIVE EFFECTS
Cathodic protection of pipes and pipelines offshore, 2:55797
SECURITY SEALS
Unique field-readable Type E security seal, 2:55967
SEDIMENTARY ROCKS
See also LIMESTONE
SINTERS

SEDIMENTARY ROCKS/PETROGENESIS
Middle--upper Devonian clastic wedge of the Franklinian geosyncline, 2:55750
SEDIMENTS/CHEMICAL ANALYSIS
Adenosine triphosphate concentration in relation to microbial biomass in aquatic systems, 2:57389 (COO-1599-120)
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57198 (LA-6869-MS)
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57197 (LA-6869)
SEDIMENTS/CHEMICAL COMPOSITION
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)
SEDIMENTS/CONTAMINATION
Vertical distribution of ^{55}Fe in the ocean, 2:57399 (RLO-2231-T1-9)
SEISMIC EFFECTS/MATHEMATICAL MODELS
Assessment of soil/structure interaction analysis procedures for nuclear power plant structures, 2:56871
SEMICONDUCTOR DIODES/FABRICATION
Research in materials science. Final technical report, 2:57100 (AD-A-037760)
SEMICONDUCTOR LASERS/EMISSION SPECTRA
Technology and spectral characteristics of Polish heterojunction lasers, 2:57296
SEMICONDUCTOR MATERIALS
(See also specific semiconductor materials.)
SEMICONDUCTOR MATERIALS/CHEMICAL VAPOR DEPOSITION
Chemical vapor deposition of thin semiconductor films for solar energy conversion, 2:56125
SEMICONDUCTOR MATERIALS/CRYSTAL DEFECTS
Science of materials. Progress report, July 1, 1976-June 30, 1977, 2:57102 (COO-1198-1181)
SEMICONDUCTOR MATERIALS/ION IMPLANTATION
System for controlling ion implantation dosage in electronic materials (Patent), 2:57184
SENSIBLE HEAT STORAGE/AQUIFERS
Experimental study of the subsurface transport of water and heat as related to the storage of solar energy, 2:56166
SENSIBLE HEAT STORAGE/COST
Thermal energy storage using large hollow steel ingots, 2:56161
SENSIBLE HEAT STORAGE/ROCK BEDS
Gravel and liquid storage system for solar thermal power plants, 2:56156
High-temperature energy storage in native rocks, 2:56159
SENSIBLE HEAT STORAGE/TECHNOLOGY ASSESSMENT
High temperature thermal energy storage (124 references), 2:56154
SEQUESTRENE
See EDTA
SERVICE WATER SYSTEMS
See AUXILIARY WATER SYSTEMS
SEWAGE/WASTE PROCESSING
Data report: Marsh/Pond system, 2:57390 (BNL-50600)
SEWAGE SLUDGE/IRRADIATION
Pasteur v curie, 2:55971
SEWAGE SLUDGE/PASTEURIZATION
Pasteur v curie, 2:55971
SEWAGE SLUDGE/RADIOSTERILIZATION
Pasteur v curie, 2:55971
SEWAGE TREATMENT
See WASTE PROCESSING
SGHWR REACTOR/DESIGN
Steam generating heavy water reactor: design and operational experience, 2:56463
SGHWR REACTOR/FUEL CYCLE
Nuclear fuel cycle: (4) the reactors, 2:56606
SGHWR REACTOR/REACTOR OPERATION
Steam generating heavy water reactor: design and operational experience, 2:56463
SHAFTS/FABRICATION
Problems of technology of manufacture of hydraulic generator shafts and related consequences for assembly and operation of hydraulic units, 2:56011
SHAFTS/MACHINING
Problems of technology of manufacture of hydraulic generator shafts and related consequences for assembly and operation of hydraulic units, 2:56011
SHALE OIL/CHEMICAL COMPOSITION
Composition of heavy shale oil...characterization of thermolysis products of the acid part of the shale, 2:55847
SHALE OIL/STRUCTURAL CHEMICAL ANALYSIS
High-sulfur shale oils. VII, 2:55849
SHALE TAR/HYDROCRACKING
Low-pressure hydrocracking of a mixture of light fractions of shale and pyrolysis tars, 2:55844
SHALE TAR/USES
Effect of shale-tar additives on the antiwear properties of motor oils, 2:55850
SHEARER LOADERS
See CUTTER LOADERS
SHEATHS (FUEL)
See FUEL CANS
SHELLS/FAILURES
Analysis and prediction of failure in tubes, 2:57257
SHELLS/STRESS ANALYSIS
Analysis and prediction of failure in tubes, 2:57257
SHELLS (CONTAINMENT)
See CONTAINMENT SHELLS
SHIELDING/MATHEMATICAL MODELS
Where are we and where are we going in reactor shielding, 2:56651 (CONF-770401-5)
SHIELDING/NUCLEAR DATA COLLECTIONS
Where are we and where are we going in reactor shielding, 2:56651 (CONF-770401-5)
SHIELDS/DESIGN
Application of conversational procedure to optimization of multi-layer radiation shielding design, 2:56689
Shielding construction for a reactor (Patent), 2:56700
SHIELDS/RADIATION STREAMING
Experimental study on fast-neutron streaming through a grid-plate shield of a liquid-metal fast breeder reactor, 2:56564
SHIPPINGPORT REACTOR/REACTOR OPERATION
[Shippingport Atomic Power Station]. Quarterly operating report, first quarter 1977, 2:56535 (DLCS-5000177)
SHIPS
See also NUCLEAR SHIPS
TANKER SHIPS
SHIPS/DIESEL ENGINES
Bridge control of marine diesel propulsion machinery, 2:57056
SHIPS/PERFORMANCE
Advanced drillship for deep water operations, 2:55761
SHIPS/POSITIONING
Advanced drillship for deep water operations, 2:55761
SHOCK TUBES/GAS FLOW
Survey of numerical methods for compressible fluids, 2:57560 (COO-3077-145)
SILICA/ADSORPTION
Adsorption of metal ions on collcidal silica, 2:56210
SILICA/DEFORMATION
Measurement of wave profiles in shock-loaded solids, 2:57156 (SAND-77-1056C)
SILICA/EVAPORATION
Silica vaporization and condensation: a potential source of fouling in coal combustion (4 refs), 2:55650 (UCRL-79146)
SILICA/SOLUBILITY
Procedure for estimating the temperature of a hot-water component in a mixed water by using a plot of dissolved silica versus enthalpy, 2:56209
SILICATES/OPTICAL PROPERTIES
Optical properties of trivalent chromium in silicate glasses: A study of energy levels in the crossing region, 2:57179
SILICON/ABSORPTIVITY
Solar energy utilization, solid state science, and a high efficiency amorphous-silicon absorber, 2:56141
SILICON/ANNEALING
Shrinkage of rod-shaped defects in boron-ion-implanted silicon (Formed during postimplantation annealing), 2:57176
SILICON/CRYSTAL DEFECTS
Shrinkage of rod-shaped defects in boron-ion-implanted silicon (Formed during postimplantation annealing), 2:57176
SILICON/CRYSTAL DOPING
Transmutation doping of silicon solar cells, 2:56029 (CONF-770439-1)
SILICON/CRYSTAL GROWTH
Development of low-cost silicon crystal growth techniques for terrestrial photovoltaic solar energy conversion, 2:56062
EFG growth of silicon ribbon for solar cells, 2:56061
Large area Czochralski silicon for solar cells, 2:56064
Large area silicon sheet task low-cost silicon solar array project. Fifth quarterly progress report, January 1, 1977-April 1, 1977, 2:56036 (ERDA/JPL/954350-77/1)
Silicon ribbon growth by a capillary action shaping technique. Quarterly technical progress report number 7, 2:56031 (ERDA/JPL/954144-77/1)
Web-dendritic ribbon growth. Quarterly report, January 1, 1977-March 31, 1977, 2:56035 (ERDA/JPL/954344-77/1)
SILICON/DISLOCATIONS
Climb of dislocations in boron-ion-implanted silicon, 2:57177
SILICON/ELECTRIC CONDUCTIVITY
Silicon Materials Task of the Low Cost Solar Array Project (Phase II). Sixth quarterly report, 1 January 1977-March 31, 1977, 2:56032 (ERDA/JPL/954331-77/2)

SILICON/ELECTRICAL PROPERTIES
Influence of grain boundaries on the electrical transport properties of polycrystalline Si films. Progress report, 2:57174 (COO-2899-1)
SILICON/ELECTRON LOSS
Extreme ultraviolet spectra of highly stripped silicon ions, 2:57219
SILICON/GRAIN BOUNDARIES
Influence of grain boundaries on the electrical transport properties of polycrystalline Si films. Progress report, 2:57174 (COO-2899-1)
SILICON/IMPURITIES
Silicon Materials Task of the Low Cost Solar Array Project (Phase II). Sixth quarterly report, 1 January 1977-March 31, 1977, 2:56032 (ERDA/JPL/954331-77/2)
SILICON/ION IMPLANTATION
Climb of dislocations in boron-ion-implanted silicon, 2:57177
Damage profiles in silicon and their impact on device reliability. Technical report number 1, October 15, 1976-March 30, 1977, 2:57182 (NP-22108)
Shrinkage of rod-shaped defects in boron-ion-implanted silicon (Formed during postimplantation annealing), 2:57176
SILICON/METALLURGICAL EFFECTS
Effect of silicon on the environmental cracking behavior of a high strength steel (AISI 4340 and 300-M), 2:57114 (LBL-6012)
SILICON/PHOTOLUMINESCENCE
Photoluminescence of hydrogenated amorphous silicon, 2:57178
SILICON/PHYSICAL RADIATION EFFECTS
Amorphization of silicon by bombardment with oxygen ions of energy below 5 keV, 2:57186
Characteristics of defect formation in Si subjected to large neutron doses (5×10^{17} to 5×10^{18} cm^{-2}), 2:57185
SILICON/PRODUCTION
Evaluation of selected chemical processes for production of low-cost silicon (Phase II). Silicon Material Task, Low-Cost Silicon Solar Array Project. Fifth-sixth quarterly progress report, October 1, 1976-March 31, 1977 (Zinc reduction of silicon tetrachloride in fluidized bed), 2:56033 (ERDA/JPL/954339-77/1)
Novel duplex vapor-electrochemical method for silicon solar cells. Quarterly progress report No. 4, November 1, 1976-January 31, 1977, 2:56039 (ERDA/JPL/954471-77/1)
Process feasibility study in support of silicon material Task I. Quarterly technical progress report (VII), 2:56034 (ERDA/JPL/954343-77/2)
Solar silicon via improved and expanded metallurgical silicon technology. Quarterly report, No. 3, 2:56041 (ERDA/JPL/954559-77/1)
SILICON/PURIFICATION
Semiconductor grade, solar silicon purification project. Technical quarterly report No. 5, January 1, 1977-March 31, 1977, 2:56038 (ERDA/JPL/954442-77/2)
SILICON/ULTRAVIOLET SPECTRA
Extreme ultraviolet spectra of highly stripped silicon ions, 2:57219
SILICON ALLOYS/FRACTURE PROPERTIES
Effect of silicon on the environmental cracking behavior of a high strength steel (AISI 4340 and 300-M), 2:57114 (LBL-6012)
SILICON ALLOYS/LATENT HEAT STORAGE
Thermal storage in metals, 2:56160
SILICON ALLOYS/THERMODYNAMIC PROPERTIES
Thermal storage in metals, 2:56160
SILICON CARBIDES/CHEMICAL VAPOR DEPOSITION
Structure of chemical vapor deposited silicon carbide, 2:57155
SILICON CARBIDES/CRYSTAL STRUCTURE
Structure of chemical vapor deposited silicon carbide, 2:57155
SILICON CARBIDES/DEPOSITION
Fuel particles with coatings without property gradients (Patent), 2:55869
SILICON SOLAR CELLS
Solar energy utilization, solid state science, and a high efficiency amorphous-silicon absorber, 2:56141
SILICON SOLAR CELLS/CLEANING
Semiconductor grade, solar silicon purification project. Technical quarterly report No. 5, January 1, 1977-March 31, 1977, 2:56038 (ERDA/JPL/954442-77/2)
SILICON SOLAR CELLS/COMPOUND PARABOLIC CONCENTRATORS
Use of solid-dielectric compound parabolic concentrators with photovoltaic devices, 2:56074
SILICON SOLAR CELLS/CRYSTAL DOPING
Transmutation doping of silicon solar cells, 2:56029 (CONF-770439-1)
SILICON SOLAR CELLS/DIFFUSION LENGTH
Determination of the diffusion length of nonbasic carriers in the base of silicon solar cells, 2:56052
SILICON SOLAR CELLS/EFFICIENCY
Analysis of silicon solar cells with stripe geometry junctions, 2:56049
SILICON SOLAR CELLS/FABRICATION
Development of low-cost silicon crystal growth techniques for terrestrial photovoltaic solar energy conversion, 2:56062
EFG growth of silicon ribbon for solar cells, 2:56061
Heterojunction solar cells of SnO_2/Si, 2:56047
Polycrystalline silicon solar cells on metallurgical silicon substrates, 2:56057
Schottky solar cells on thin epitaxial silicon, 2:56075
Silicon Materials Task of the Low Cost Solar Array Project (Phase II). Sixth quarterly report, 1 January 1977-March 31, 1977, 2:56032 (ERDA/JPL/954331-77/2)
Silicon solar cells using natural inversion layers found in thermally-oxidized p-silicon (Experimental and theoretical study), 2:56048
Solar cells using discharge-produced amorphous silicon, 2:56046
Solar cells from polysilicon rods, 2:56056
SILICON SOLAR CELLS/PERFORMANCE TESTING
Effects of outdoor exposure on solar cell modules in the ERDA/NASA Lewis Research Center Ststems Test Facility, 2:56043 (ERDA/NASA/1022-77/13)
SILICON SOLAR CELLS/P-N JUNCTIONS
Analysis of silicon solar cells with stripe geometry junctions, 2:56049
SILICON SOLAR CELLS/PRODUCTION
Low energy production processes in manufacturing of silicon solar cells, 2:56065
SILICON SOLAR CELLS/REVIEWS
Review: silicon solar cells for terrestrial applications, 2:56045
SILICON SOLAR CELLS/SEMICONDUCTOR JUNCTIONS
Silicon solar cells using natural inversion layers found in thermally-oxidized p-silicon (Experimental and theoretical study), 2:56048
SILICON SOLAR CELLS/TECHNOLOGY ASSESSMENT
Review: silicon solar cells for terrestrial applications, 2:56045
SILICON SOLAR CELLS/WEATHERING
Effects of outdoor exposure on solar cell modules in the ERDA/NASA Lewis Research Center Ststems Test Facility, 2:56043 (ERDA/NASA/1022-77/13)
SILICONES/DEGASSING
Organics used in microelectronics: a review of outgassing materials and effects, 2:57173 (SAND-76-5854C)
SILVER/X-RAY FLUORESCENCE ANALYSIS
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57198 (LA-6869-MS)
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57197 (LA-6869)
SILVER ORES/RESERVES
Canadian reserves of seven metals, 2:56933
SILVER-ZINC BATTERIES/ELECTRODES
Electrode assembly for bipolar battery (Patent application), 2:56903
SIMULATORS
Graph model of behavior simulator (Interactive simulator developed as part of UCLA SARA system), 2:57821 (UCLA-34P214-42)
SIMULATORS/DESIGN
Investigation of hybrid systems for power systems analysis. The ac/hybrid power system simulator. Final report, 2:56356 (EEI-RP-90-2)
SIMULATORS/PERFORMANCE
Investigation of hybrid systems for power systems analysis. The ac/hybrid power system simulator. Final report, 2:56356 (EEI-RP-90-2)
SINGLE CRYSTALS
See MONOCRYSTALS
SINTERED MATERIALS/SHOCK WAVES
Response of porous beryllium to static and dynamic loading, 2:57118 (UCRL-79712)
SINTERS/CRYSTAL GROWTH
Factors influencing crystalline form of calcareous sinters, 2:56213
SITE SELECTION/DATA ACQUISITION SYSTEMS
INSITE: information on nuclear sites data system, 2:56746
SITES (REACTOR)
See REACTOR SITES
SLABS/NEUTRON SPECTRA
Measurement of space dependent angular thermal neutron spectra in natural uranium-light water slab, 2:56649
SLAGS
Study of the mineral matter distribution in pulverized fuel coals with respect to slag deposit formation in boiler furnaces: Phase 1. Interim report, July-September 1976 (Wetting and contact angle measurements in a high temperature furnace), 2:55642 (FE-2316-2)
SLAGS/VISCOSITY
Gas generator research and development: BI-GAS process. Quarterly report, January-March 1977, 2:55567 (FE-1207-29)
SLUGS (FUEL)
See FUEL RODS

SLURRIES (FUEL)
See FUEL SLURRIES
SLURRY PIPELINES/ECONOMICS
Western coal transportation: unit trains or slurry pipelines. Final report, 2:57025 (PB-264916)
SLURRY PIPELINES/MONITORING
Measurements of coal slurry concentration in haulage pipelines by nuclear techniques, 2:55714
SLURRY PIPELINES/PUMPING
Transmission of solids by pipeline, 2:55715
SLURRY PIPELINES/TESTING
Technological analysis of conditions of separation of Polish gas and power coal slurries by flotation (13 refs), 2:55716
SNR REACTOR
See SNR-1 REACTOR
SNR-1 REACTOR/REACTOR VESSELS
Experiences on welding and testing during the construction of the austenitic reactor vessel for SNR 300, 2:56559
SNR-300 REACTOR
See SNR-1 REACTOR
SODIUM/CHEMICAL ANALYSIS
Sodium characterization during the starting period of a sodium loop, 2:56490 (CONF-760503-P1)
SODIUM/COMBUSTION
Experimental studies on sodium fires application to reactors (LMFBR), 2:56580 (NP-tr-1980)
SODIUM/CORROSIVE EFFECTS
Corrosion of steels in liquid sodium (LMFBR), 2:56525 (CONF-760503-P1)
Corrosion and creep of pressurized stainless-steel tubes in liquid sodium at 873 and 973°K, 2:56542
Influence of sodium on the mechanical properties of fuel element cladding, 2:56519 (CONF-760503-P1)
Influence of dynamic sodium on the creep properties of stabilized austenitic steels, 2:56520 (CONF-760503-P1)
Low cycle fatigue testing in flowing sodium at elevated temperatures (LMFBR), 2:56521 (CONF-760503-P1)
Material effects in LMFBR sodium systems, 2:56517 (CONF-760503-P1)
Solubility of oxygen in liquid sodium: effect on interpretation of corrosion data, 2:56527 (CONF-760503-P1)
SODIUM/ELECTRON-ATOM COLLISIONS
Electron scattering by laser-excited atoms, 2:57525
SODIUM/FILTRATION
Improved method for operating sodium system cold traps, 2:56543
SODIUM/FIRES
Aerosol measurements and modeling for fast reactor safety. Task 7. Quarterly progress report, October 1-December 31, 1976 (LMFBR; time dependent aerosol suspension behavior), 2:56768 (BMI-NUREG-1969)
Effect of humidity on the burning rate of sodium droplets, 2:56823
SODIUM/PURIFICATION
Evolution of sodium purification: RAPSODIE, PHENIX, SUPER-PHENIX, 2:56484 (CONF-760503-P1)
Experience with sodium purification on large-scale operational test loops in France, 2:56487 (CONF-760503-P1)
Identification of impurities in sodium and its purification, 2:56488 (CONF-760503-P1)
Sodium and cover gas chemistry in the high temperature sodium facility, 2:56489 (CONF-760503-P1)
Sodium characterization during the starting period of a sodium loop, 2:56490 (CONF-760503-P1)
SODIUM/SAMPLING
Specimen equilibration device (or multipurpose sampler) for the analysis of nonmetals in liquid sodium, 2:57195 (RDT-C-8-8T(7-77))
SODIUM/SOLVENT PROPERTIES
Solubility of oxygen in liquid sodium: effect on interpretation of corrosion data, 2:56527 (CONF-760503-P1)
SODIUM ALLOYS/CATALYTIC EFFECTS
Surface and electrocatalytic properties of tungsten bronzes, 2:57129 (IS-M-96)
SODIUM CHLORIDES/CORROSIVE EFFECTS
The stress corrosion resistance and the cryogenic temperature mechanical properties of annealed Nitronic 60 bar material, 2:57115 (N-77-16149)
SODIUM CHLORIDES/PHYSICAL PROPERTIES
Volumetric properties of aqueous sodium chloride solutions from 0° to 500°C at pressures up to 2000 bars based on a regression of available data in the literature, 2:56208 (USGS-BULL-1421-C)
SODIUM COMPLEXES/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance studies of diamagnetic metal-aminopolycarboxylate complexes, 2:57229
SODIUM HYDROXIDES/LATENT HEAT STORAGE
Inorganic phase change materials for energy storage in solar thermal program ($NaNO_3$ and NaOH mixture), 2:56158
SODIUM NITRATES/LATENT HEAT STORAGE
Inorganic phase change materials for energy storage in solar thermal program ($NaNO_3$ and NaOH mixture), 2:56158
SODIUM OXIDES/DIFFUSION
Aerosol measurements and modeling for fast reactor safety. Task 7. Quarterly progress report, October 1-December 31, 1976 (LMFBR; time dependent aerosol suspension behavior), 2:56768 (BMI-NUREG-1969)
SODIUM-SULFUR BATTERIES/ELECTROCHEMISTRY
Sodium-sulfur battery, 2:56893
SOILS
See also PERMAFROST
SOILS/CHEMICAL ANALYSIS
Determination of total beryllium in soils by atomic absorption spectrophotometry, 2:57204 (RFP-Trans-225)
SOILS/ENVIRONMENTAL TRANSPORT
Determination of total beryllium in soils by atomic absorption spectrophotometry, 2:57204 (RFP-Trans-225)
SOILS/FLUID FLOW
Calculated and observed nonisothermal multiphase in flow in vertical columns (Mathematical model for movement of air, water vapor, and liquid water in dry desert soil), 2:57375 (ARH-SA-278)
SOILS/PERMEABILITY
Permeability of fly ash and fly ash stabilized soils. Final report on highway research project no. 47, 2:55648 (PB-265229)
SOILS/RADIATION MONITORING
Dose assessment at Bikini Atoll (^{90}Sr, ^{137}Cs), 2:57437 (UCRL-51879(Pt.5))
SOILS/RADIONUCLIDE MIGRATION
Effects of substrate type and arsenic dosage level on arsenic behavior in grassland microcosms. Part I. Preliminary results on ^{74}As transport, 2:57380 (CONF-770647-1)
SOLAR AIR CONDITIONERS/COST
Basic solar energy balance, 2:56110
SOLAR AIR CONDITIONERS/DESIGN
The design of a solar energy collection system to augment heating and cooling for a commercial office building, 2:56098 (N-77-16446)
SOLAR AIR CONDITIONERS/EFFICIENCY
Statistical investigation of the efficiency of solar and evaporative coolers in the conditions of Turkmenia, 2:56101
SOLAR AIR CONDITIONERS/INSTALLATION
Look at vocational training for the solar energy industry, 2:56109
SOLAR AIR CONDITIONERS/LATENT HEAT STORAGE
Immiscible fluid: heat of fusion energy storage system, 2:56168
Thermal energy storage with saturated aqueous solutions, 2:56165
Thermocrete heat storage materials: applications and performance specifications, 2:56167
SOLAR AIR CONDITIONERS/MAINTENANCE
Look at vocational training for the solar energy industry, 2:56109
SOLAR AIR CONDITIONERS/PERFORMANCE
Basic solar energy balance, 2:56110
Method for estimating solar heating and cooling system performance, 2:56105
SOLAR AIR CONDITIONERS/RETROFITTING
Basic solar energy balance, 2:56110
SOLAR AIR CONDITIONING/COMMERCIALIZATION
Facilitating the use of solar building technologies; a report on work in progress, 2:56026
SOLAR AIR CONDITIONING/HEAT STORAGE
New directions in heat storage for buildings, 2:56153
SOLAR AIR CONDITIONING/MEETINGS
CCMS solar energy pilot study. Solar heating and cooling systems in buildings. Report to the CCMS plenary, Duesseldorf, Federal Republic of Germany, February 8-9, 1977, 2:56100 (UMD-4908-8)
SOLAR AIR CONDITIONING/THERMOCHEMICAL HEAT STORAGE
Thermal energy storage by the sulfuric acid-water system, 2:56162
SOLAR ATMOSPHERE/RADIOISOTOPES
Radioactive nuclei and the gamma-ray background of the quiet Sun, 2:57484
SOLAR CELL ARRAYS/BONDING
Integral glass encapsulation for solar arrays. Quarterly progress report No. 4, May 1977, 2:56040 (ERDA/JPL/954521-77/2)
SOLAR CELL ARRAYS/COVERINGS
Integral glass encapsulation for solar arrays. Quarterly progress report No. 4, May 1977, 2:56040 (ERDA/JPL/954521-77/2)
SOLAR CELL ARRAYS/DESIGN
Design considerations of solar arrays for terrestrial applications, 2:56063
SOLAR CELL ARRAYS/HYBRID SYSTEMS
Extension of the Hottel-Whillier-Bliss model to the analysis of combined photovoltaic/thermal flat plate collectors, 2:56067
SOLAR CELL ARRAYS/PERFORMANCE
Method of determination of operational values of electrical parameters of solar batteries, 2:56054
SOLAR CELL ARRAYS/PERFORMANCE TESTING
Gas stream thermal cycling apparatus, 2:56058

SOLAR CELL ARRAYS/PRODUCTION
Automated array assembly. Annual report, 2:56037 (ERDA/JPL/954352-77/1)
Initial production of CdS photovoltaic products, 2:56069
SOLAR CELL ARRAYS/RESEARCH PROGRAMS
Status of the ERDA photovoltaic materials and device studies, 2:56066
SOLAR CELL ARRAYS/SOLAR CONCENTRATORS
Terrestrial concentrating photovoltaic power system studies, 2:56068
SOLAR CELL ARRAYS/STATISTICAL MODELS
Method of determination of operational values of electrical parameters of solar batteries, 2:56054
SOLAR CELL ARRAYS/THERMAL ANALYSIS
Extension of the Hottel-Whillier-Bliss model to the analysis of combined photovoltaic/thermal flat plate collectors, 2:56067
SOLAR CELL ARRAYS/THERMAL CYCLING
Gas stream thermal cycling apparatus, 2:56058
SOLAR CELLS
See also CADMIUM SULFIDE SOLAR CELLS
SILICON SOLAR CELLS
SOLAR CELLS/COMPOSITE MATERIALS
Effective medium theory of optical properties of small particle composites, 2:57169
SOLAR CELLS/COVERINGS
Real time outdoor exposure testing of solar cell modules and component materials, 2:56042 (ERDA/NASA/1022-77/10)
SOLAR CELLS/EFFICIENCY
Basic mechanisms governing solar-cell efficiency (Semiconductor theory), 2:56071
SOLAR CELLS/ELECTRICAL PROPERTIES
Determination of parameters of the current-versus-voltage characteristic of solar cells, 2:56053
SOLAR CELLS/MEETINGS
Sharing the Sun: solar technology in the seventies. Volume 6. Photovoltaics and materials. Contains sections 7 and 12, 2:56059
SOLAR CELLS/PROTECTIVE COATINGS
Utilization of transparent heat reflecting coatings in solar energy converters, 2:56055
SOLAR CELLS/REVIEWS
Solar cells for terrestrial applications (87 references), 2:56060
SOLAR CELLS/SOLAR CONCENTRATORS
Combination of photo cones and photo wedges with radiation receivers, 2:56122
SOLAR CELLS/WEATHERING
Real time outdoor exposure testing of solar cell modules and component materials, 2:56042 (ERDA/NASA/1022-77/10)
SOLAR COLLECTORS
See also CONCENTRATING COLLECTORS
FLAT PLATE COLLECTORS
Solar energy source book (Catalog of products and services), 2:56103
SOLAR COLLECTORS/ABSORPTIVITY
Optical properties of selectively absorbing Ni/Al_2O_3 composite films, 2:57168
SOLAR COLLECTORS/DESIGN
Design of energy-integrated building subsystems and their evaluation, 2:57012
Method of theoretical calculation of the area required for a hot box -type heat receiver, 2:56135
Reinforced pillow solar water heater, 2:56116
SOLAR COLLECTORS/EFFICIENCY
Newborn in Italy: the new generation of solar panels, 2:56127
SOLAR COLLECTORS/GETTERS
Use of getters in evacuated solar collectors (For minimizing heat loss by conduction), 2:56145
SOLAR COLLECTORS/MATERIALS
Application of aluminum alloys for solar heating and cooling systems, 2:56144
Sharing the Sun: solar technology in the seventies. Volume 6. Photovoltaics and materials. Contains sections 7 and 12, 2:56059
SOLAR COLLECTORS/MATERIALS TESTING
Weatherability of solar energy utilization materials: preliminary discussions, 2:56146
SOLAR COLLECTORS/PERFORMANCE TESTING
Experimental investigation with artificial sunlight of a solar hot-water heater, 2:56113
Newborn in Italy: the new generation of solar panels, 2:56127
SOLAR COLLECTORS/RESEARCH PROGRAMS
Industrial applications of solar energy. Quarterly report, 2:56093 (SAN/1132-1)
SOLAR COLLECTORS/SPECTRALLY SELECTIVE SURFACES
Alcoa 655 selective surface for aluminum, 2:56139
Analytical and experimental treatment of a spray-on selective coating: application to collector design, 2:56140
Solar energy utilization, solid state science, and a high efficiency amorphous-silicon absorber, 2:56141
SOLAR COLLECTORS/WEATHERING
Weatherability of solar energy utilization materials: preliminary discussions, 2:56146
SOLAR CONCENTRATORS
See also COMPOUND PARABOLIC CONCENTRATORS
MIRRORS
SOLAR REFLECTORS
SOLAR CONCENTRATORS/CALCULATION METHODS
Methods of calculation of profiles of focusing cones and focusing wedges, 2:56128
SOLAR CONCENTRATORS/COST
Preliminary system analysis of a fixed mirror solar power central station. Final report, 2:56079 (EPRI-ER-434(6-77))
SOLAR CONCENTRATORS/DESIGN
Combination of photo cones and photo wedges with radiation receivers, 2:56122
Compound concentrators with spherical radiation sources, 2:56132
Concentrating capacity of spherical facets, 2:56130
Sectional facetal solar energy concentrator, 2:56134
SOLAR CONCENTRATORS/FABRICATION
Sectional facetal solar energy concentrator, 2:56134
SOLAR CONCENTRATORS/MATERIALS
Sharing the Sun: solar technology in the seventies. Volume 6. Photovoltaics and materials. Contains sections 7 and 12, 2:56059
SOLAR CONCENTRATORS/MEASURING INSTRUMENTS
Experimental setup to measure spatial and energetic characteristics of solar concentrators, 2:56129
SOLAR CONCENTRATORS/OPTICAL PROPERTIES
Calculation of optical characteristics of radiant energy receivers in high temperature investigations, 2:56131
Experimental setup to measure spatial and energetic characteristics of solar concentrators, 2:56129
SOLAR CONCENTRATORS/PERFORMANCE
Concentrating capacity of spherical facets, 2:56130
Paraboloid-hyperboloid concentrating systems and their precision, 2:56123
Preliminary system analysis of a fixed mirror solar power central station. Final report, 2:56079 (EPRI-ER-434(6-77))
Preliminary system analysis of a fixed mirror solar power central station. Final report, 2:56088 (EPRI-ER-434)
SOLAR CONCENTRATORS/PROTECTIVE COATINGS
Aging of silazane protective coating in vacuum, 2:56124
SOLAR COOLING SYSTEMS
See also SOLAR AIR CONDITIONING
See SOLAR AIR CONDITIONERS
SOLAR COOLING SYSTEMS/DEMONSTRATION PROGRAMS
Sandia's solar total energy program, 2:56099 (SAND-75-5880)
SOLAR COOLING SYSTEMS/EQUIPMENT
Solar energy source book (Catalog of products and services), 2:56103
SOLAR COOLING SYSTEMS/PERFORMANCE TESTING
Systems approach to solar heating and cooling systems, 2:56096 (CONF-770359-1)
SOLAR ELECTRONS/BREMSSTRAHLUNG
Impulsive solar x-ray bursts. 3. Polarization and directivity of bremsstrahlung radiation from a beam of electrons directed toward the photosphere, 2:57482 (N-77-16976)
Impulsive solar x-ray bursts. 4: polarization, directivity and spectrum of the reflected and total bremsstrahlung radiation from a beam of electrons directed toward the photosphere, 2:57483 (N-77-16977)
SOLAR ENERGY
Characterization of industrial process heat, including the potential for solar or nuclear systems to supply this market, 2:56094
SOLAR ENERGY/BIBLIOGRAPHIES
Energy, 2:57834
SOLAR ENERGY/EDUCATION
Academic program in solar energy science education, 2:56017
Integrating solar energy concepts into chemistry/science curriculum, 2:56018
SOLAR ENERGY/FEASIBILITY STUDIES
Report on the Western Energy Expansion Study, 2:56986 (NP-22295)
SOLAR ENERGY/FORECASTING
Comparative analysis of solar energy applications to the year 2000 and beyond, 2:56015
SOLAR ENERGY/INFORMATION CENTERS
Solar energy collection at Arizona State University, 2:56020
SOLAR ENERGY/INFORMATION SYSTEMS
"Solar switchboard": an interim analysis of an experiment in the dissemination of solar energy information to the public, 2:56021
Solar energy information system (a proposal), 2:56019
SOLAR ENERGY/LEGAL ASPECTS
Basis for the development of a solar energy cadaster, 2:56025
SOLAR ENERGY/MATHEMATICAL MODELS
Basis for the development of a solar energy cadaster, 2:56025

SOLAR ENERGY/MEETINGS
Sharing the Sun: solar technology in the seventies. Volume 8. Storage, water heater, data communication education. Contains sections 13.1, 13.2, 13.3, 15, 16, 5, 2:56016
SOLAR ENERGY/RESEARCH PROGRAMS
Industrial applications of solar energy. Quarterly report, 2:56093 (SAN/1132-1)
Overview of the federal solar energy program and current technology status, 2:56014
SOLAR ENERGY/THERMOCHEMICAL HEAT STORAGE
Chemical methods of storing thermal energy, 2:56155
Storage of solar energy by inorganic oxide/hydroxides, 2:56163
SOLAR ENERGY CONVERSION/HYDROGEN PRODUCTION
Assessment of hydrogen as a means to store solar energy, 2:56027
SOLAR FLARES/NUCLEAR REACTIONS
Radioactive nuclei and the gamma-ray background of the quiet Sun, 2:57484
SOLAR FLUX/MEASURING METHODS
Comparison of a thermopile broadband detector and a photon detector for the measurement of solar radiation. Part I. Analysis of simultaneous data. Part II. Cosine response functions, 2:56022 (PB-265282)
SOLAR HEATING SYSTEMS/ARCHITECTURE
Solar energy system design approaches for architects, 2:56108
SOLAR HEATING SYSTEMS/COST
Basic solar energy balance, 2:56110
SOLAR HEATING SYSTEMS/DEMONSTRATION PROGRAMS
Sandia's solar total energy program, 2:56099 (SAND-75-5880)
SOLAR HEATING SYSTEMS/DESIGN
Solar glass house with subsoil heat accumulator, 2:56104
The design of a solar energy collection system to augment heating and cooling for a commercial office building, 2:56098 (N-77-16446)
SOLAR HEATING SYSTEMS/EQUIPMENT
Solar energy source book (Catalog of products and services), 2:56103
SOLAR HEATING SYSTEMS/HEAT STORAGE
High temperature thermal energy storage (124 references), 2:56154
SOLAR HEATING SYSTEMS/INSTALLATION
Look at vocational training for the solar energy industry, 2:56109
SOLAR HEATING SYSTEMS/LATENT HEAT STORAGE
Immiscible fluid: heat of fusion energy storage system, 2:56168
Thermal energy storage with saturated aqueous solutions, 2:56165
Thermocrete heat storage materials: applications and performance specifications, 2:56167
SOLAR HEATING SYSTEMS/MAINTENANCE
Look at vocational training for the solar energy industry, 2:56109
SOLAR HEATING SYSTEMS/PERFORMANCE
Basic solar energy balance, 2:56110
Method for estimating solar heating and cooling system performance, 2:56105
SOLAR HEATING SYSTEMS/PERFORMANCE TESTING
Systems approach to solar heating and cooling systems, 2:56096 (CONF-770359-1)
SOLAR HEATING SYSTEMS/RETROFITTING
Basic solar energy balance, 2:56110
SOLAR HEATING SYSTEMS/SENSIBLE HEAT STORAGE
Experimental study of the subsurface transport of water and heat as related to the storage of solar energy, 2:56166
SOLAR HEATING SYSTEMS/THERMOCHEMICAL HEAT STORAGE
Thermal energy storage by the sulfuric acid-water system, 2:56162
SOLAR POWER PLANTS
See also ORBITAL SOLAR POWER PLANTS
PHOTOVOLTAIC POWER PLANTS
SOLAR THERMAL POWER PLANTS
SOLAR POWER PLANTS/ENERGY STORAGE
Utilization of solar radiation at large solar power plants with hydraulic storage, 2:56083
SOLAR RADIATION/CALCULATION METHODS
Calculation of the parameters of a radiant flux receiver, taking into account its exchange with the environment, 2:56024
SOLAR REFLECTORS
See also PARABOLIC REFLECTORS
SOLAR REFLECTORS/MATERIALS TESTING
Weatherability of solar energy utilization materials: preliminary discussions, 2:56146
SOLAR REFLECTORS/PRISMS
Prisms with total internal reflection as solar reflectors, 2:56147
SOLAR REFLECTORS/WEATHERING
Weatherability of solar energy utilization materials: preliminary discussions, 2:56146
SOLAR REFRIGERATORS/THERMODYNAMIC CYCLES
Conjugated cycles of single-loop solar energy refrigerating plants, 2:56084
SOLAR SPACE HEATING/COMMERCIALIZATION
Facilitating the use of solar building technologies; a report on work in progress, 2:56026
SOLAR SPACE HEATING/FEASIBILITY STUDIES
Regional conditions and the possibility of application of low temperature solar heaters in Yakutian mines, 2:56102
SOLAR SPACE HEATING/HEAT STORAGE
New directions in heat storage for buildings, 2:56153
SOLAR SPACE HEATING/MEETINGS
CCMS solar energy pilot study. Solar heating and cooling systems in buildings. Report to the CCMS plenary, Duesseldorf, Federal Republic of Germany, February 8-9, 1977, 2:56100 (UMD-4908-8)
SOLAR STILLS/FILMS
Experimental investigations of solar distilling installations with different film surfaces, 2:56118
SOLAR THERMAL POWER PLANTS
Report on solar thermal power systems and their potential for utility applications, 2:56081
SOLAR THERMAL POWER PLANTS/HEAT STORAGE
High temperature thermal energy storage (124 references), 2:56154
SOLAR THERMAL POWER PLANTS/LATENT HEAT STORAGE
Demand sensitive energy storage in molten salts, 2:56157
SOLAR THERMAL POWER PLANTS/MATHEMATICAL MODELS
Preliminary system analysis of a fixed mirror solar power central station. Final report, 2:56079 (EPRI-ER-434(6-77))
SOLAR THERMAL POWER PLANTS/PERFORMANCE
Preliminary system analysis of a fixed mirror solar power central station. Final report, 2:56088 (EPRI-ER-434)
SOLAR THERMAL POWER PLANTS/RESEARCH PROGRAMS
Industrial applications of solar energy. Quarterly report, 2:56093 (SAN/1132-1)
SOLAR THERMAL POWER PLANTS/SENSIBLE HEAT STORAGE
Gravel and liquid storage system for solar thermal power plants, 2:56156
High-temperature energy storage in native rocks, 2:56159
Thermal energy storage using large hollow steel ingots, 2:56161
SOLAR THERMAL POWER PLANTS/SOLAR CONCENTRATORS
Preliminary system analysis of a fixed mirror solar power central station. Final report, 2:56079 (EPRI-ER-434(6-77))
SOLAR THERMAL POWER PLANTS/THERMOCHEMICAL HEAT STORAGE
Thermal storage by paired ammoniated salts, 2:56151
SOLAR WATER HEATERS
Design of a solar heating system using seasonal heat storage (Provident House), 2:56107
Solar energy source book (Catalog of products and services), 2:56103
SOLAR WATER HEATERS/COST
Solar hot water heating system, 2:56115
SOLCOST: solar hot water handbook. A simplified design method for sizing and costing residential and commercial solar service hot water systems, 2:56111 (DSE/2531-2)
SOLAR WATER HEATERS/DEMONSTRATION PROGRAMS
Sandia's solar total energy program, 2:56099 (SAND-75-5880)
SOLAR WATER HEATERS/DESIGN
Reinforced pillow solar water heater, 2:56116
Solar hot water heating system, 2:56115
SOLAR WATER HEATERS/ECONOMICS
Solar water preheater for use in a cold climate, 2:56114
SOLAR WATER HEATERS/INSTALLATION
Look at vocational training for the solar energy industry, 2:56109
SOLAR WATER HEATERS/MAINTENANCE
Look at vocational training for the solar energy industry, 2:56109
SOLAR WATER HEATERS/MARKET
Solar water heating in dwellings. survey of selected prospective users in sydney, 2:56112 (PB-264151)
SOLAR WATER HEATERS/MATHEMATICAL MODELS
Solar water preheater for use in a cold climate, 2:56114
SOLAR WATER HEATERS/MEETINGS
Sharing the Sun: solar technology in the seventies. Volume 8. Storage, water heater, data communication education. Contains sections 13.1, 13.2, 13.3, 15, 16, 5, 2:56016
SOLAR WATER HEATERS/PERFORMANCE TESTING
Experimental investigation with artificial sunlight of a solar hot-water heater, 2:56113
SOLAR WATER HEATERS/SIZE
SOLCOST: solar hot water handbook. A simplified design method for sizing and costing residential and commercial solar service hot water systems, 2:56111 (DSE/2531-2)
SOLAR WATER PUMPS/DESIGN
Solar water-raising plant with a diaphragm pump, 2:56095
SOLAR X-RAY BURSTS/ENERGY SPECTRA
Impulsive solar x-ray bursts. 3. Polarization and directivity of bremsstrahlung radiation from a beam of electrons directed toward the photosphere, 2:57482 (N-77-16976)

Impulsive solar x-ray bursts. 4: polarization, directivity and spectrum of the reflected and total bremsstrahlung radiation from a beam of electrons directed toward the photosphere, 2:57483 (N-77-16977)
SOLAR X-RAY BURSTS/POLARIZATION
Impulsive solar x-ray bursts. 3. Polarization and directivity of bremsstrahlung radiation from a beam of electrons directed toward the photosphere, 2:57482 (N-77-16976)
Impulsive solar x-ray bursts. 4: polarization, directivity and spectrum of the reflected and total bremsstrahlung radiation from a beam of electrons directed toward the photosphere, 2:57483 (N-77-16977)
SOLID FUELS/BUBBLES
Equilibrium index for fission gas bubbles, 2:56709
SOLID FUELS/FLAMES
Flame suppression on cylindrical fuel rods, 2:57248
SOLID STATE LASERS/MODE LOCKING
Kinematic mode locking in a solid-state laser, 2:57293
SOLID STATE PHYSICS
Ukrainian Physics Journal (Cover-to-cover translation into English of Ukrainskii Fizicheskii Zhurnal, no. 9 (September 1971)), 2:57089 (AEC-tr-7297/9)
SOLID WASTES
See also MILL TAILINGS
SOLID WASTES/COMBUSTION
European waste-to-energy systems: case study of the thermal complex of Toulouse-Le Mirail (France), 2:55999 (CONS/2103-1)
European waste-to-energy systems: case study of Geneva-Cheneviers (Switzerland), 2:56987 (CONS/2103-2)
Refuse incineration and heating in middle-sized cities, 2:56001
SOLID WASTES/INVENTORIES
Energy potential from construction and demolition wood wastes. Final report 1976, 2:56000 (PB-265392)
SOLID WASTES/RECYCLING
Impact of the Federal tax code on resource recovery. Final report (Effect of tax-subsidy elimination), 2:56929 (PB-264886)
SOLID WASTES/USES
European waste-to-energy systems. Case study of Munich: Munich North IA and IB, Munich North II, Munich South IV and V, 2:56981 (CONS/2103-4)
SOLID WASTES/WASTE DISPOSAL
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-1. Environmental considerations affecting the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55605 (FE-1752-16)
SOLIDS/DEFORMATION
Measurement of wave profiles in shock-loaded solids, 2:57156 (SAND-77-1056C)
SOLUTION HEAT/ISOTOPE EFFECTS
Condensed phase isotope effects, especially vapor pressure isotope effects: aqueous solutions, 2:57234
SOLVATED ELECTRONS/CHEMICAL REACTION KINETICS
Reaction of e/sub aq/$^-$ + H_3O^+. Concentration effects of acid or salts, 2:57239
SOLVATED ELECTRONS/SCAVENGING
Ultraviolet part of transient absorption spectrum induced in liquid ammonia by nanosecond pulse radiolysis (23°C), 2:57237
SOLVENT-REFINED COAL
Catalytic hydrogenation of coal-derived liquids. Interim report, March 1977-May 1977, 2:55556 (FE-2034-7)
SOLVENT-REFINED COAL/CHEMICAL ANALYSIS
Approaches to the analysis of solvent refined lignite, 2:55620 (CONF-760885-)
SOLVENT-REFINED COAL/CHEMICAL COMPOSITION
Kinetics and mechanisms of solvent refining coal, 2:55619 (CONF-760885-)
Solvent refined coal (SRC) process operation of solvent refined coal pilot plant at Wilsonville, Alabama. Monthly technical progress report for June 1977, 2:55625 (FE-2270-17)
SOLVENT-REFINED COAL/HYDROGENATION
Homogeneous catalytic hydrogenations of complex carbonaceous substrates (16 references), 2:55555 (BNWL-SA-6055)
SOLVENT-REFINED COAL/MATERIALS HANDLING
Chemical characterization, handling, and refining of SRC to liquid fuels. Final report on Task 3: handling characteristics of SRC (17 refs), 2:55712 (FE-2003-18a)
SOLVENT-REFINED COAL/MOLECULAR STRUCTURE
Approaches to the analysis of solvent refined lignite, 2:55620 (CONF-760885-)
SOLVENT-REFINED COAL/PNEUMATIC TRANSPORT
Chemical characterization, handling, and refining of SRC to liquid fuels. Final report on Task 3: handling characteristics of SRC (17 refs), 2:55712 (FE-2003-18a)
SOLVENT-REFINED COAL/PRODUCTION
Solvent Refined Coal (SRC) process. Quarterly technical progress report, July-September 1976, 2:55621 (FE-496-129)
SOLVENT-REFINED COAL/STORAGE
Chemical characterization, handling, and refining of SRC to liquid fuels. Final report on Task 3: handling characteristics of SRC (17 refs), 2:55712 (FE-2003-18a)
SOLVENT-REFINING COAL PLANTS
See COAL PREPARATION PLANTS
SOOT/CHEMICAL REACTION YIELD
Influence of additives obtained from alkaline metals on soot concentration of hydrocarbon diffusive-laminar flames, 2:55980
SOUTH CAROLINA/SEISMIC SURVEYS
Studies related to the seismicity of the Charleston-Summerville Area, South Carolina, 2:57470
SOVIET BREEDER REACTOR-5
See SBR-5 REACTOR
SOVIET UNION
See USSR
SPACE HEATING/ENERGY DEMAND
Household fuel demand analysis, 2:57013 (CONF-770225-1)
SPACE HEATING/FUEL CONSUMPTION
The costs of cold weather and the conservation of residential heating gas. Staff report (Cost-effective investments for each state), 2:57015 (PB-264759)
SPACE LATTICES
See CRYSTAL LATTICES
SPACE POWER REACTORS/RESEARCH PROGRAMS
Space-based power conversion and power relay systems: preliminary analysis of alternate systems. Interim report, 8 Jul. 1975 - 26 May 1976, 2:56080 (N-77-16447)
SPACE VEHICLES/COMPOSITE MATERIALS
Advanced composites: electromagnetic properties, vulnerabilities, and protective measures, 2:57167 (R-1979-AF)
SPACE VEHICLES/ENERGY STORAGE
Energy storage during orbital and interplanetary missions, 2:56883 (AED-CONF-76-377-002)
SPACE VEHICLES/NICKEL-CADMIUM BATTERIES
Testing of NiCd cells over geostationary orbit type cycling period, 2:56898 (N-77-10661)
SPACECRAFT POWER SUPPLIES/ELECTRIC BATTERIES
Secondary aerospace batteries and battery materials: a bibliography, 1969 - 1974, 2:56888 (N-77-16437)
SPARK IGNITION ENGINES/EQUIPMENT
Improving automotive fuel economy with accessory drives. (MS-4171), 2:57074 (CONF-761028-4)
SPECTRALLY SELECTIVE SURFACES
Low cost coatings for flat plate solar collectors, 2:56126
Solar energy utilization, solid state science, and a high efficiency amorphous-silicon absorber, 2:56141
SPECTRALLY SELECTIVE SURFACES/ABSORPTIVITY
Analytical and experimental treatment of a spray-on selective coating: application to collector design, 2:56140
SPECTRALLY SELECTIVE SURFACES/COST
Financial incentives for the fabrication of improved absorption coatings for the flat plate collector, 2:56142
SPECTRALLY SELECTIVE SURFACES/ELECTROPLATING
Development of low-cost procedures for application of solar selective black chrome, 2:56137
Sharing the Sun: solar technology in the seventies. Volume 6, 2:56136
SPECTRALLY SELECTIVE SURFACES/EMISSIVITY
Analytical and experimental treatment of a spray-on selective coating: application to collector design, 2:56140
SPECTRALLY SELECTIVE SURFACES/FABRICATION
Chemical vapor deposition of thin semiconductor films for solar energy conversion, 2:56125
SPECTRALLY SELECTIVE SURFACES/PERFORMANCE
Alcoa 655 selective surface for aluminum, 2:56139
Chemical vapor deposition of thin semiconductor films for solar energy conversion, 2:56125
SPECTROPHOTOMETERS/PERFORMANCE
Evaluation of the LASL automated spectrophotometer for uranium determination at submilligram levels, 2:57203 (LA-6867)
SPEED REGULATORS/EVALUATION
Some aspects of the problem of control of Kaluga Turbine Plant turbines with generators of a new series, 2:56336
SPENT FUEL CASKS/DESIGN
Design challenges of serving a maturing LWR industry's spent fuel transportation needs, 2:57279
LMFBR spent fuel transportation technology development, 2:57280
SPENT FUEL CASKS/REMOTE HANDLING EQUIPMENT
Dry spent fuel cask handling system, 2:56655
SPENT FUEL ELEMENTS/DISSOLUTION
Nuclear safety of the ten-well insert for the SRP fuel element dissolver, 2:55880 (DP-1429)
Reactivity measurements under conditions typical to fuel element dissolution, 2:55886
SPENT FUEL STORAGE
B and W-designed close-spaced fuel storage racks, 2:56412

HI-CAP high-capacity fuel rack design, 2:56656
High-density fuel storage for boiling water reactors, 2:56370
Spent fuel storage in the USA, 2:55890
Spent fuel storage: utility perspective, 2:55891
Spent fuel storage basis for new nuclear power plants, 2:55892
Westinghouse high-density spent fuel rack design, 2:56411
SPENT FUELS/FLUORIDE VOLATILITY PROCESS
Purification process studies for the reprocessing by fluoride volatility method, 2:55882 (JAERI-M-6592)
SPENT FUELS/PUREX PROCESS
Solvent extraction of enriched uranium fuels at the Savannah River Plant, 2:55881 (DP-MS-76-77)
SPENT FUELS/REPROCESSING
Completing the nuclear fuel cycle, 2:55883
Spent nuclear fuel: prospects for output, storage and reprocessing, 2:56373
SPENT FUELS/TRANSPORT
Transportation status and problems in the back end of the fuel cycle, 2:55889
SPENT SHALES/POROSITY
Characterizing cinder rock with the scanning electron microscope (From in-situ retorting), 2:55834 (UCID-17492)
SPHERATOR/ENERGY LOSSES
Energy loss rates of energetic ions injected into the FM-1 spherator, 2:57632
SPHERATOR/NEUTRAL ATOM BEAM INJECTION
Energy loss rates of energetic ions injected into the FM-1 spherator, 2:57632
SPHERES (FUEL)
See FUEL SPHERES
SPORES/AGE ESTIMATION
Biostratigraphy and taxonomy of devonian megaspores, arctic canada, 2:57466
SPRAY PONDS
See COOLING PONDS
SPRINGS
(Mechanical springs only.)
SPRINGS/SPECIFICATIONS
Coal gasification valves. Phase I. Design analysis report, 2:55578 (FE-2355-15)
SRC PROCESS
Characterization of coal liquids. Intermediate report for the period July-December 1975. Upgrading solvent refined coal process filter feed, 2:55624 (FE-2010-01)
Investigations on the nature of preasphaltenes derived from solvent refined coal conversion products, 2:55633 (CONF-760885-)
SRC PROCESS/CHEMICAL REACTION KINETICS
Kinetics and mechanisms of solvent refining coal, 2:55619 (CONF-760885-)
SRC PROCESS/PILOT PLANTS
Solvent Refined Coal (SRC) process. Quarterly technical progress report, July-September 1976, 2:55621 (FE-496-129)
Solvent Refined Coal (SRC) process. Quarterly technical progress report, January-March 1977, 2:55622 (FE-496-134)
Solvent refined coal (SRC) process. Development of a process for producing an ashless, low-sulfur fuel from coal. Volume III. Pilot plant development work. Part 3. Startup and operation of the SRC Pilot Plant. Research and development report No. 53. Interim report No. 22. Period covered: June 1974-April 1977, 2:55623 (FE-496-T13)
Solvent refined coal (SRC) process operation of solvent refined coal pilot plant at Wilsonville, Alabama. Monthly technical progress report for June 1977, 2:55625 (FE-2270-17)
Status of Wilsonville Solvent Refined Coal pilot plant. Interim report, 2:55601 (EPRI-1234)
SRC-II PROCESS/BENCH-SCALE EXPERIMENTS
Solvent Refined Coal (SRC) process. Quarterly technical progress report, July-September 1976, 2:55621 (FE-496-129)
SRC-II PROCESS/RESEARCH PROGRAMS
Solvent Refined Coal (SRC) process. Quarterly technical progress report, January-March 1977, 2:55622 (FE-496-134)
SR-OB REACTOR
See SUBCRITICAL ASSEMBLIES
STABLE ISOTOPES/TRACER TECHNIQUES
Argonne Bioanalytical Center: a resource for collaborative biomedical applications of stable isotopes, 2:57407 (CONF-761234-3)
STAINLESS STEEL-304/CORROSION
Corrosion of ferrous alloys in nitrogen contaminated liquid lithium, 2:57133 (CONF-760503-P1)
Corrosion of iron-base alloys by lithium, 2:57134 (CONF-760503-P2)
STAINLESS STEEL-304/DEGASSING
Radiation cleanup of vacuum systems (radiation-induced outgassing). Progress report, September 15, 1976-September 14, 1977, 2:57787 (COO-4093-1)
STAINLESS STEEL-304/EROSION
Testing, identification, and evaluation of commercial and "advanced experimental" materials and coatings under design conditions simulating fuel power cycle combinations. Task II. Evaluation of heat exchanger materials for use in coal-fired fluidized bed combustion environment. Monthly technical progress report No. 14, 2:55725 (FE-2325-14)
STAINLESS STEEL-304/FATIGUE
Cyclic stress strain behavior of four nuclear pressure vessel materials, 2:56676
STAINLESS STEEL-304/NEUTRON REACTIONS
Hydrogen and helium production cross sections for 15-MeV neutrons on types 316 and 304 stainless steel, 2:57594
STAINLESS STEEL-304/PHYSICAL RADIATION EFFECTS
Clinch River Breeder Reactor Plant. Irradiated EBR-II duct crushing test and analysis, 2:56755 (CRBRP-ARD-0164)
Momentum transfer and damage energy gradient effects on helium permeability, 2:57148
STAINLESS STEEL-304/SURFACE PROPERTIES
Methane formation in tritium gas exposed to stainless steel, 2:55968 (UCRL-52262)
STAINLESS STEEL-304/TENSILE PROPERTIES
Clinch River Breeder Reactor Plant. Irradiated EBR-II duct crushing test and analysis, 2:56755 (CRBRP-ARD-0164)
STAINLESS STEEL-310/CORROSION
Sulfidation of 310 stainless steel at sulfur potentials encountered in coal conversion systems, 2:55548 (N-76-31332)
STAINLESS STEEL-310/EROSION
Testing, identification, and evaluation of commercial and "advanced experimental" materials and coatings under design conditions simulating fuel power cycle combinations. Task II. Evaluation of heat exchanger materials for use in coal-fired fluidized bed combustion environment. Monthly technical progress report No. 14, 2:55725 (FE-2325-14)
STAINLESS STEEL-316/CORROSION
Corrosion, transport, and deposition of stainless steel in liquid sodium, 2:56522 (CONF-760503-P1)
In-reactor corrosion behavior of stainless steel in high temperature sodium, 2:56523 (CONF-760503-P1)
Influence of LMFBR fuel pin temperature profiles on corrosion rate, 2:56524 (CONF-760503-P1)
STAINLESS STEEL-316/FATIGUE
Low cycle fatigue testing in flowing sodium at elevated temperatures, 2:56521 (CONF-760503-P1)
STAINLESS STEEL-316/NEUTRON REACTIONS
Hydrogen and helium production cross sections for 15-MeV neutrons on types 316 and 304 stainless steel, 2:57594
STAINLESS STEEL-316/PHYSICAL RADIATION EFFECTS
Lifetime considerations for a fusion reactor first wall of type 316 stainless steel, 2:57795
STAINLESS STEEL-316L/STRESS CORROSION
Stress-corrosion studies on materials used for surgical implants, 2:57138
STAINLESS STEEL-321/CORROSION
Corrosion of iron-base alloys by lithium, 2:57134 (CONF-760503-P2)
STAINLESS STEEL-347/EROSION
Testing, identification, and evaluation of commercial and "advanced experimental" materials and coatings under design conditions simulating fuel power cycle combinations. Task II. Evaluation of heat exchanger materials for use in coal-fired fluidized bed combustion environment. Monthly technical progress report No. 14, 2:55725 (FE-2325-14)
STAINLESS STEELS
See also STAINLESS STEEL-304
STAINLESS STEEL-310
STAINLESS STEEL-316
STAINLESS STEEL-321
STAINLESS STEEL-347
STAINLESS STEELS/CORROSION
Corrosion and creep of pressurized stainless-steel tubes in liquid sodium at 873 and 973°K, 2:56542
Influence of sodium on the mechanical properties of fuel element cladding, 2:56519 (CONF-760503-P1)
Influence of dynamic sodium on the creep properties of stabilized austenitic steels, 2:56520 (CONF-760503-P1)
Material effects in LMFBR sodium systems, 2:56517 (CONF-760503-P1)
Thermodynamic and diffusion studies on corrosion of austenitic stainless steel in liquid sodium, 2:56526 (CONF-760503-P1)
STAINLESS STEELS/CORROSION RESISTANCE
Sodium environment effects to structural materials for fast reactors, 2:56540 (PNC-J-225-76-02)
STAINLESS STEELS/CREEP
Corrosion and creep of pressurized stainless-steel tubes in liquid sodium at 873 and 973°K, 2:56542

STAINLESS STEELS/MECHANICAL PROPERTIES
Effect of liquid sodium thermochemical reactions with stainless steels on mechanical response (LMFBR), 2:56518 (CONF-760503-P1)
Steam generator materials engineering eleventh quarterly report, January-March 1977, 2:57112 (GEFR-14029-11)
The stress corrosion resistance and the cryogenic temperature mechanical properties of annealed Nitronic 60 bar material, 2:57115 (N-77-16149)
STAINLESS STEELS/PITTING CORROSION
The stress corrosion resistance and the cryogenic temperature mechanical properties of annealed Nitronic 60 bar material, 2:57115 (N-77-16149)
STAINLESS STEELS/PROTECTIVE COATINGS
Coatings application for fusion research, 2:57099
STAINLESS STEELS/STRESS CORROSION
The stress corrosion resistance and the cryogenic temperature mechanical properties of annealed Nitronic 60 bar material, 2:57115 (N-77-16149)
STANDARD MAN
See REFERENCE MAN
STANDARDS (CALIBRATION)
See CALIBRATION STANDARDS
STANDING CROP
See BIOMASS
STARS
See also MAGNETIC STARS
MAIN SEQUENCE STARS
SUN
SUPERNOVAE
STARS/RED SHIFT
Extinction towards the South Galactic Pole determined from reddening of A and F stars, 2:57486
STATE GOVERNMENT/TAXES
State taxation of mineral deposits and production. Final report (Western states), 2:56956 (PB-264575)
STEAM/FLOW MODELS
Motion of an evaporating drop in superheated steam flow, 2:57303
STEAM/LAMINAR FLOW
Determination of the stability boundary of a laminar flow of steam with film boiling, 2:57300
STEAM/TWO-PHASE FLOW
One-dimensional motion of highly wet steam in nozzles, 2:57305
STEAM CONDENSERS/PERFORMANCE TESTING
Development and tests of a condenser/degasser designed by VTI for special water purification systems of nuclear power plants, 2:56681
STEAM GENERATING HEAVY WATER REACTOR
See SGHWR REACTOR
STEAM GENERATORS/CORROSION
Calculation of wastage by small water leaks in sodium heated steam generators (LMFBR), 2:56506 (CONF-760503-P1)
STEAM GENERATORS/DESIGN
Low temperature steam generator (Patent; Molten Salt Reactor), 2:56459
Research, development and realization of sectional modular sodium heated steam generator, 2:56566
STEAM GENERATORS/FABRICATION
Alloy 800 for liquid-metal fast breeder reactor steam generators, 2:56565
Production of components for pressurized water reactors in the plants of FRAMATOME, 2:56421
Production of components for pressurized water reactors in the plants of Framatome, 2:56422
STEAM GENERATORS/FAILURES
Steam generator tube failures: world experience in water-cooled nuclear reactors in 1975, 2:56397
STEAM GENERATORS/LEAK DETECTORS
Small leak damage and protection systems in steam generators (LMFBR), 2:56508 (CONF-760503-P1)
STEAM GENERATORS/LEAK TESTING
Sodium and steam leak simulation studies for fluidized bed steam generators (LMFBR), 2:56510 (CONF-760503-P1)
STEAM GENERATORS/LEAKS
Small leak shutdown, location, and behavior in LMFBR steam generators, 2:56507 (CONF-760503-P1)
Some problems of leaks in sodium-water steam generator (LMFBR), 2:56504 (CONF-760503-P1)
STEAM GENERATORS/MANUFACTURING
Development of steam generator construction at the Taganrog Krasnyy Kotelshchik plant in the tenth five-year plan period, 2:56310
STEAM GENERATORS/MATERIALS
Qualification of Alloy 800 for sodium heated steam generators (LMFBR), 2:56505 (CONF-760503-P1)
STEAM GENERATORS/METALLURGY
Materials engineering issues, LMFBR steam generators, 2:56503 (CONF-760503-P1)
STEAM GENERATORS/MOLTEN METAL-WATER REACTIONS
Small leak damage and protection systems in steam generators (LMFBR), 2:56508 (CONF-760503-P1)
STEAM GENERATORS/PRESSURE DROP
Design correlation for pressure drops in coiled, once-through steam generators, 2:56562
STEAM GENERATORS/STRESS ANALYSIS
Benefit of using a global tridimensional finite element calculation for the analysis of the primary part of a PWR steam generator, 2:56418
STEAM LINES/CREEP
Permissible value of compensation stresses in piping systems of power plants, operating in creep conditions, 2:56289
STEAM LINES/SAFETY STANDARDS
Permissible value of compensation stresses in piping systems of power plants, operating in creep conditions, 2:56289
STEAM LINES/SERVICE LIFE
Increasing service life of steamlines by repeated heat treatment of pipes, 2:56255
STEAM LINES/STRESS ANALYSIS
Permissible value of compensation stresses in piping systems of power plants, operating in creep conditions, 2:56289
STEAM SEPARATORS/COMPARATIVE EVALUATIONS
Investigation of the turbine separator stage with increased axial gap, 2:56286
STEAM SEPARATORS/DESIGN
Investigation of the turbine separator stage with increased axial gap, 2:56286
Investigation of a turboseparator with a freely rotating impeller, 2:56272
STEAM SEPARATORS/EFFICIENCY
Investigation of a turboseparator with a freely rotating impeller, 2:56272
STEAM SUPERHEATERS
See SUPERHEATERS
STEAM SYSTEMS/PRESSURE CONTROL
Using sliding live steam pressure to control the capacity of power units of nuclear power plants, 2:56664
STEAM SYSTEMS/VALVES
Steam-flow and seismic tests of nuclear ball valves verify design and fabrication, 2:56660
STEAM TURBINES/CLEANING
Refinement of the regime of chemical cleaning of k-300-240 KHTZ turbines under load, 2:56254
STEAM TURBINES/CONTROL SYSTEMS
Analysis of the control system of a high-capacity turbine for a nuclear power plant, 2:56735
Apparatus for controlling vapor temperature in a nuclear power plant (Patent), 2:56697
Selection and investigation of turbine capacity control system for nuclear power plants, 2:56730
STEAM TURBINES/COOLING SYSTEMS
Operation of the K-200-130 turbine in motor regime conditions, 2:56253
STEAM TURBINES/DUCTS
Calculation of the motion of a medium in schematized elements of turbine ducts, 2:56331
STEAM TURBINES/EFFICIENCY
Effect of the throughput capacity of nozzle cascades on the economic efficiency and reliability of a turbine installation, 2:56318
Results of natural-size investigations of variable conditions of operation of the low pressure section of a district heating turbine, 2:56304
STEAM TURBINES/FATIGUE
Fatigue damage on large components, 2:56692
STEAM TURBINES/FLOW MODELS
Analysis of the influence of the parameters of a turbine stage with a high d/l ratio on stability of its operation, 2:56285
STEAM TURBINES/MANUFACTURING
State of the art and trends in the development of foreign turbine construction for nuclear power plants, 2:56696
STEAM TURBINES/OPERATION
Analysis of the influence of the parameters of a turbine stage with a high d/l ratio on stability of its operation, 2:56285
Analysis of characteristics of impulse discharge of high-capacity steam turbines, 2:56280
Investigation of the operation of a T-100-130-type turbine made by the UTMZ plant in steamless regime, 2:56287
Operation of the K-200-130 turbine in motor regime conditions, 2:56253
STEAM TURBINES/QUALITY ASSURANCE
Means for extending the service life of the metal of high-temperature elements of high-capacity power units, 2:57121
STEAM TURBINES/RELIABILITY
Effect of the throughput capacity of nozzle cascades on the economic efficiency and reliability of a turbine installation, 2:56318

STEAM TURBINES/ROTORS
Effect of rigidity and damping of bearings on the value of threshold capacity of self-exciting vibrations of steam turbine rotors, 2:56340
Heat treatment of large-sized welded steam turbine rotors for nuclear power plants, 2:56268
STEAM TURBINES/SEALS
Problems of improving steam turbine seals, 2:56252
STEAM TURBINES/SERVICE LIFE
Evaluation of service life of steam turbine casings in thermal fatigue conditions, 2:56302
STEAM TURBINES/SPEED REGULATORS
Some aspects of the problem of control of Kaluga Turbine Plant turbines with generators of a new series, 2:56336
STEAM TURBINES/STABILITY
Analysis of the influence of the parameters of a turbine stage with a high d/l ratio on stability of its operation, 2:56285
STEAM TURBINES/STEAM SEPARATORS
Investigation of the turbine separator stage with increased axial gap, 2:56286
STEAM TURBINES/STRESS ANALYSIS
Investigation of the axial force in the turbine section with a bleeding chamber, 2:56300
STEAM TURBINES/TEMPERATURE MEASUREMENT
Warming-up of frames of double-walled medium-pressure cylinder of a K-300-240 turbine made by Kharkov Turbine Works, 2:56303
STEAM TURBINES/TURBINE BLADES
Automation of drawing and graphic work in turbine construction, 2:56339
Experience of vibrational detuning of blading, 2:56274
Investigation of a stage with a small d/sub av$/l/sub blade/ ratio and lowered radial gradient of the degree of reactivity, 2:56305
Problem of formation of salt deposits and their effect on physical processes in flow-through parts of turbines, 2:56298
Stamping unique blades from titanium alloys, 2:56275
Synthesis of optimal design of variable-section rotor blades, 2:56320
STEAM TURBINES/VENTILATION
Calculation and analysis of steady-state regimes of low pressure cylinders of steam turbines, 2:56325
STEEL-ASTM-A508/FATIGUE
Cyclic stress strain behavior of four nuclear pressure vessel materials, 2:56676
STEEL-ASTM-A508/FORGING
A-508 class 3 forgings for pressure vessels, 2:56420
STEEL-ASTM-A533/FATIGUE
Cyclic stress strain behavior of four nuclear pressure vessel materials, 2:56676
STEEL-ASTM-A533-B/FRACTURE PROPERTIES
Improvement of fracture toughness in reactor pressure vessel steel plates, 2:56385
STEEL-ASTM-A543/WELDED JOINTS
Fracture toughness of welded joints of ASTM A543 steel plate, 2:56674
STEELS
See also CHROMIUM-MOLYBDENUM STEELS
CHROMIUM-NICKEL STEELS
NICKEL STEELS
STAINLESS STEELS
STEEL-ASTM-A533
STEELS/COLD WORKING
Mastering the process of cold bending of pipes for a small radius in Soviet boilermaking, 2:57098
STEELS/CORROSION
Corrosion of steels in liquid sodium (LMFBR), 2:56525 (CONF-760503-P1)
STEELS/MANUFACTURING
Considerate steelmaking helps cut steel costs, 2:57046
STEELS/PHYSICAL RADIATION EFFECTS
Neutron exposure for safety limitation for reactor pressure vessel steels, 2:57140 (AED-Conf-76-556-004)
STEELS/PRODUCTION
Electric conductive billet heaters, 2:57034
STEELS/PROTECTIVE COATINGS
Some questions of high-temperature vanadic corrosion and principal lines of development of heat-resistant materials, 2:57137
STEELS/SENSIBLE HEAT STORAGE
Thermal energy storage using large hollow steel ingots, 2:56161
STEELS/SERVICE LIFE
Ways to solve the problem of extending the service life of existing and projected steam pipelines beyond 100,000 hr, 2:57122
STEELS/X-RAY RADIOGRAPHY
Assessment of thick section radiography. Final report, 2:57307 (EPRI-NP-461)
STELLITE/FRICTION
Friction and wear behavior of Colmonoy and Stellite alloys in sodium environment, 2:56496 (CONF-760503-P1)
Investigations into the self-welding behavior of metallic materials exposed to sodium, 2:56499 (CONF-760503-P1)
STELLITE/WEAR
Friction and wear behavior of Colmonoy and Stellite alloys in sodium environment, 2:56496 (CONF-760503-P1)
STORAGE (SPENT FUEL)
See SPENT FUEL STORAGE
STRATIFIED CHARGE ENGINES/DESIGN
Stratified combustion type engine (Patent), 2:57080
STREAK PHOTOGRAPHY/PERFORMANCE
Subpicosecond proximity-focused streak camera for x-ray and visible light, 2:57643
Ultrafast x-ray diagnostics for laser fusion experiments, 2:57644
STREAMS
See also RIVERS
STREAMS/THERMAL POLLUTION
Indiana stream-temperature characteristics. Water-resources investigations (final), 2:57402 (PB-265346)
STREAMS/WATER QUALITY
Effects of geothermal energy utilization on stream biota and water quality at The Geysers, California. Final report (Big Sulphur, Little Sulphur, Squaw, and Pieta Creeks), 2:56195 (NP-21722)
STRESS ANALYSIS/COMPUTER CODES
MODSAP: a modified version of the program SAP IV for the static and dynamic response of linear and localized nonlinear structures, 2:57808 (GA-A-14405)
STRONG INTERACTIONS/HAMILTONIANS
Non-Abelian gauge fields and nonrelativistic bound states, 2:57579
STRONTIUM/ELECTRON COLLISIONS
Investigation of plasmon excitation by oblique incidence of a beam of primary electrons of medium energy in reflection experiments (50 to 500 eV, 0 to 88°), 2:57498
STRONTIUM/ELECTRON-ATOM COLLISIONS
Absolute effective cross sections for the excitation of a strontium atom from metastable states by electron collision (Excitation functions), 2:57515
STRONTIUM 90/ENVIRONMENTAL TRANSPORT
Finite element models for sediment and contaminant transport in surface waters. Transport of sediments and radionuclides in the Clinch River (^{137}Cs, ^{90}Sr, ^{198}Au), 2:57398 (BNWL-2227)
STRONTIUM COMPLEXES/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance studies of diamagnetic metal-aminopolycarboxylate complexes, 2:57229
STRONTIUM COMPOUNDS/OXIDATION
Oxidation behavior of nickel-chromium-aluminum-yttrium - magnesium oxide and nickel-chromium-aluminum-yttrium - zirconate type of cermets, 2:57163 (N-77-16115)
STRONTIUM ISOTOPES/ISOTOPE RATIO
Evidence for the Azores mantle plume from strontium isotope geochemistry of the Central North Atlantic, 2:57476
STRUCTURAL BUCKLING
See DEFORMATION
STRUCTURES (MECHANICS)
See MECHANICAL STRUCTURES
STUDS
See FASTENERS
SU-4 GROUPS/SYMMETRY BREAKING
Intermultiplet mixing of the vector mesons in a nonperturbative approach to broken SU(4), 2:57586
SUBCRITICAL ASSEMBLIES/FISSION FOIL DETECTORS
Monte Carlo calculations of cadmium cutoff energies and an ansatz formula, 2:56759
SUBCRITICAL FLOW
See LAMINAR FLOW
SUBSONIC FLOW/CALCULATION METHODS
Quasithreedimensional calculation of flow in turbine stages, 2:56327
SUBSURFACE STRUCTURES/DESIGN
Selection of the shape of cross-section of mine workings driven by combines, 2:55692
SUBSURFACE STRUCTURES/MECHANICAL PROPERTIES
Modern materials for underground support, 2:55689
SUBTERRENE PENETRATORS/DESIGN
Selection of the shape of cross-section of mine workings driven by combines, 2:55692
SULFATES/NATURAL OCCURRENCE
Inorganic sulfur in coal, 2:55645
SULFIDES/NATURAL OCCURRENCE
Inorganic sulfur in coal, 2:55645
SULFUR DIOXIDE/CHEMICAL ANALYSIS
Characterization of ash from coal-fired power plants. Milestone report May 75-Mar 76, 2:55649 (PB-265374)
SULFUR DIOXIDE/CHEMICAL RADIATION EFFECTS
Substituting polyketones and polysulfones for polyethylene, 2:57171
SULFUR DIOXIDE/COMBUSTION KINETICS
Combustion of carbon. Effect of sulfur dioxide, 2:55804

SULFUR DIOXIDE/CRYSTAL STRUCTURE
Novel co-ordination of sulphur dioxide. The crystal and molecular structure of nitrosyl(sulfur dioxide)bis(triphenylphosphine)rhodium, 2:57233
SULFUR DIOXIDE/MONITORING
Individual air pollution monitors. 2. Examination of some nonoccupational research and regulatory uses and needs, 2:57352 (BNL-50637)
The chemistry, dispersion and transport of air pollutants emitted from fossil fuel power plants in California: chemical analysis of particulate samples for sulfate, nitrate, and trace element composition. Final report, Sep-Nov 1974, 2:57358 (PB-264823)
SULFUR DIOXIDE/REMOVAL
Removal of contaminants from industrial gaseous effluents, 2:55654
SULFUR DIOXIDE/SYNTHESIS
Novel co-ordination of sulphur dioxide. The crystal and molecular structure of nitrosyl(sulfur dioxide)bis(triphenylphosphine)rhodium, 2:57233
SULFUR FLUORIDES/CHEMICAL REACTION KINETICS
Model for unimolecular reaction of sulfur hexafluoride, 2:57213
SULFUR HYDRIDES
See HYDROGEN SULFIDES
SULFURIC ACID/THERMOCHEMICAL HEAT STORAGE
Thermal energy storage by the sulfuric acid-water system, 2:56162
SUN
See also SOLAR ATMOSPHERE
SUN/GAMMA RADIATION
Radioactive nuclei and the gamma-ray background of the quiet Sun, 2:57484
SUN/INFRARED RADIATION
Infrared upconverter for astronomical imaging, 2:57341
SUPER PHENIX REACTOR/COOLANT CLEANUP SYSTEMS
Evolution of sodium purification: RAPSODIE, PHENIX, SUPER-PHENIX, 2:56484 (CONF-760503-P1)
SUPERCHARGERS/DESIGN
Calculation of processes in the gas dynamic exchanger for diesel engine supercharging, 2:57055
SUPERCONDUCTING CABLES/PERFORMANCE
Helium research in support of superconducting power transmission. Annual report, July 1975-September 1976, 2:56360 (CONS/3800-1)
SUPERCONDUCTING CABLES/RESEARCH PROGRAMS
Helium research in support of superconducting power transmission. Annual report, July 1975-September 1976, 2:56360 (CONS/3800-1)
SUPERCONDUCTING GENERATORS/COOLING SYSTEMS
Cooling system intended for cryogenerators, 2:57271
Some aspects of the cryogenics of a superconducting generator, 2:57270
SUPERCONDUCTING GENERATORS/OPERATION
Few aspects of the behavior of a cryogenerator in a big electric system, 2:57269
Some aspects of the cryogenics of a superconducting generator, 2:57270
SUPERCONDUCTING GENERATORS/PERFORMANCE
Method of study for cryogenerators in variable operating conditions. physical environment of the field magnet in operation, 2:57268
SUPERCONDUCTING GENERATORS/RELIABILITY
Applications of superconducting magnets to energy with particular emphasis on fusion power, 2:57740
SUPERCONDUCTING JUNCTIONS
See also JOSEPHSON JUNCTIONS
SUPERCONDUCTING JUNCTIONS/CRITICAL CURRENT
Josephson effect in tunnel junctions with vanadium and vanadium oxide, 2:57267
SUPERCONDUCTING JUNCTIONS/JOSEPHSON EFFECT
Josephson effect in tunnel junctions with vanadium and vanadium oxide, 2:57267
SUPERCONDUCTING MAGNETS/DEFORMATION
Lateral buckling and vibrations of superconducting magnets for magnetic fusion reactors. Progress report, October 1976-May 1977, 2:57731 (COO-2780-3)
SUPERCONDUCTING MAGNETS/DESIGN
Engineering considerations of the toroidal magnet and dewar for UWMAK. II. A Wisconsin Tokamak fusion reactor design, 2:57718
Superconducting toroidal field magnets for a tokamak engineering test reactor, 2:57739
SUPERCONDUCTING MAGNETS/MATHEMATICAL MODELS
Computational model for predicting the characteristics of a superconducting magnet, 2:57734
SUPERCONDUCTING MAGNETS/MECHANICAL VIBRATIONS
Lateral buckling and vibrations of superconducting magnets for magnetic fusion reactors. Progress report, October 1976-May 1977, 2:57731 (COO-2780-3)
SUPERCONDUCTING MAGNETS/PERFORMANCE
Conceptual demountable TF magnet design for UWMAK-II fusion reactor, 2:57735
SUPERCONDUCTING MAGNETS/RELIABILITY
Applications of superconducting magnets to energy with particular emphasis on fusion power, 2:57740
SUPERCONDUCTING MAGNETS/SAFETY
Safety of large fusion magnet systems, 2:57732
SUPERCONDUCTING MAGNETS/TEMPERATURE MEASUREMENT
Cryogenic instrumentation needs in the controlled thermonuclear research program, 2:57738
SUPERCONDUCTING MAGNETS/USES
Applications of superconducting magnets to energy with particular emphasis on fusion power, 2:57740
SUPERCONDUCTORS
See also TYPE-II SUPERCONDUCTORS
SUPERCONDUCTORS/FABRICATION
Analytical study of space processing of immiscible materials for superconductors and electrical contacts. Final report, 28 May 1975 - 30 Sep. 1976, 2:57092 (N-77-16075)
SUPERCONDUCTORS/RESEARCH PROGRAMS
Research in materials science. Final technical report (Materials Research Lab, Univ. of Illinois at Urbana-Champaign), 2:57100 (AD-A-037760)
SUPERCONDUCTORS/TRANSITION TEMPERATURE
Manifestations of 2 1/2-order transitions and Kohn singularities in the pressure dependence of the superconducting transition temperature, 2:57625
SUPERHEATERS/DESIGN
Selection of thermal diagram of intermediate superheaters of gas and oil fuel-fired boilers, 2:56334
SUPERHEAVY ELEMENTS
See TRANS 104 ELEMENTS
SUPERNOVAE/PHOTOMETRY
Light curves of type II supernovae, 2:57480
SUPERNOVAE/STAR MODELS
Light curves of type II supernovae, 2:57480
SUPEROXIDE RADICALS
See PERHYDROXYL RADICALS
SUPERTANKERS
See TANKER SHIPS
SUPPORTS/SEISMIC EFFECTS
Stability of supports of mine workings under seismic loads, 2:55694
SURFACE AIR
See also AIR
EARTH ATMOSPHERE
SURFACE AIR/RADIATION MONITORING
Sensitive method for continuous air monitoring for ^{14}C and ^{3}H, 2:57374 (MLM-2441(TR))
SURFACE AIR/TEMPERATURE GRADIENTS
Influence of temperature stratification on the thermal performance of a dry cooling tower with natural draught, 2:56242
SURFACE AIR/THERMAL EFFICIENCY
Influence of temperature stratification on the thermal performance of a dry cooling tower with natural draught, 2:56242
SURFACE MINING/CONVEYORS
Method and apparatus for strip mining (Patent; 13 claims), 2:55674
SURFACE MINING/ENVIRONMENTAL IMPACTS
Strip-mining and small mammals in southern Iowa (36 refs), 2:55671 (IS-ICP-44)
SURFACE MINING/LAND RECLAMATION
Land rehabilitation research at Pacific Northwest Laboratories, 2:57387 (BNWL-SA-6089)
SURFACE MINING/MINING EQUIPMENT
Brown coal: open pit technique reaches new order of magnitude, 2:55683
Surface mining of brown coal, its environmental influence and future prospects: illustrated by the example of the Rhenish brown coal mining industry, 2:55669 (AED-CONF-76-417-001)
SURFACE MINING/PLANNING
Study to determine research and development needs in western mining. Final report, 2:57281 (PB-264429)
SURFACE MINING/REVIEWS
Mining engineering's annual review of coal and industrial minerals. I, 2:55684
SURFACE MINING/SHAFT EXCAVATIONS
Method and apparatus for strip mining (Patent; 13 claims), 2:55674
SURFACE WATERS
See also COASTAL WATERS
RIVERS
SEAS
STREAMS
WATER RESERVOIRS
SURFACE WATERS/CHEMICAL COMPOSITION
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)

SURGES/CONTROL
Investigation of surge protection of compressors of gas turbine power plants, 2:56335
SUSPENSIONS (FUEL)
See FUEL SLURRIES
SUSQUEHANNA RIVER/SEDIMENTS
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)
SUSQUEHANNA RIVER/SURFACE WATERS
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)
SWEDEN/BWR TYPE REACTORS
Water chemistry in Swedish boiling water reactors: operational experience, 2:56376
SWITZERLAND/GEOTHERMAL RESOURCES
Utilization of geothermal energy for heating of Swiss cities, 2:56174
SWITZERLAND/MUNICIPAL WASTES
European waste-to-energy systems: case study of Geneva-Cheneviers (Switzerland), 2:56987 (CONS/2103-2)
SYNCHROTRON RADIATION/ATOMS
Atomic physics with synchrotron radiation, 2:57558
SYNTHANE PROCESS/FUEL FEEDING SYSTEMS
Coal pressurization and feeding use of a lock hopper system, 2:55563 (CONF-770655-1)
SYNTHANE PROCESS/PRESSURE VESSELS
Feasibility study of prestressed concrete pressure vessels for coal gasifiers, 2:55583 (ORNL-5312)
SYNTHESIS GAS/SYNTHESIS
Production of clean synthesis or fuel gas (Patent; from liquid hydrocarbonaceous fuels such as petroleum or its products, coal products, shale oils, or slurry of solid carbonaceous fuel), 2:55988
Production of clean synthesis or fuel gas (Patent; from liquid hydrocarbonaceous fuels such as petroleum or its products, coal products, shale oils, or slurry of solid carbonaceous fuel), 2:55989
Production of clean synthesis or fuel gas (Patent; by-product steam), 2:55990
SYNTHETIC FUELS
See also HYDROGEN FUELS
MOBIL M-GASOLINE PROCESS
SYNTHETIC FUELS/SYNTHESIS
Synthetic carbonaceous fuels and feedstocks from oxides of carbon and nuclear power, 2:55981 (BNL-22785)
SYNTHETIC FUELS INDUSTRY/MANPOWER
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-5. Manpower requirements. Final report, January 1975-December 1976, 2:55607 (FE-1752-20)
SYNTHETIC FUELS INDUSTRY/PLANNING
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. The role of synthetic liquids from coal in meeting future energy demand. Final report, January 1975-December 1976, 2:55603 (FE-1752-14)
SYNTHETIC FUELS INDUSTRY/SOCIO-ECONOMIC FACTORS
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-5. Manpower requirements. Final report, January 1975-December 1976, 2:55607 (FE-1752-20)
SYNTHETIC PETROLEUM/CHEMICAL ANALYSIS
Characterization of coal syncrudes at BERC, 2:55641 (CONF-760885-)
SYNTHOIL PROCESS
Catalytic hydrogenation of coal-derived liquids. Interim report, March 1977-May 1977, 2:55556 (FE-2034-7)
SYNTHOIL PROCESS/ECONOMICS
Evaluation of the Synthoil process. Volume I. Process design and economic evaluation of a 100,000-barrel/stream day facility, 2:55615 (ORNL-5209(Vol.1))
SYNTHOIL PROCESS/EVALUATION
Evaluation of the Synthoil process. Volume I. Process design and economic evaluation of a 100,000-barrel/stream day facility, 2:55615 (ORNL-5209(Vol.1))
SYNTHOIL PROCESS/FLOWSHEETS
Engineering evaluations of coal conversion processes. Part I. Hydrocarbonization and Synthoil: information base, process selection, and preliminary evaluation of alternatives, 2:55617 (ORNL/TM-5034)
Evaluation of the Synthoil process. Volume III. Unit block flow diagrams for a 100,000 barrel/stream day facility, 2:55616 (ORNL-5211)
SYNTHOIL PROCESS/TWO-PHASE FLOW
Synthoil hydrodynamics. Final report, 2:55600 (COO-0056-4)
SYNTHOIL PROCESS/WASTE PROCESSING
Engineering evaluations of coal conversion processes. Part I. Hydrocarbonization and Synthoil: information base, process selection, and preliminary evaluation of alternatives, 2:55617 (ORNL/TM-5034)
SYSTEMS ANALYSIS/ERRORS
Fuzzy set theoretic approach to systems analysis, 2:56599

T

TANKER SHIPS/CONSTRUCTION
Ocean transport and storage of liquefied natural gas, 2:55823
TANKER SHIPS/MOORINGS
North Sea offshore loading, what is the problem, 2:55799
TANKS/MECHANICAL STRUCTURES
Effect of support on an inclined measuring tank on the load on measuring probes of batching tank scales in a skip pit bottom, 2:55717
TANKS/SUPPORTS
Effect of support on an inclined measuring tank on the load on measuring probes of batching tank scales in a skip pit bottom, 2:55717
TANTALUM/CHEMICAL VAPOR DEPOSITION
Chemical vapor deposition of tantalum on graphite cloth for making hot pressed fiber reinforced carbide-graphite composite, 2:57164 (LA-UR-77-1261)
TANTALUM 181 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
TANTALUM ALLOYS/COMPATIBILITY
Compatibility of bismuth and bismuth-lithium solutions with refractory metals and graphite, 2:57108 (CONF-760503-P2)
TANTALUM CARBIDES/FABRICATION
Chemical vapor deposition of tantalum on graphite cloth for making hot pressed fiber reinforced carbide-graphite composite, 2:57164 (LA-UR-77-1261)
TANTALUM CARBIDES/WETTABILITY
Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R-1746)
TAR SANDS
See OIL SANDS
TATB
(1,3,5-Triamino-2,4,6-trinitrobenzene.)
TATB/PHYSICAL PROPERTIES
TATB formulation study. Final report, 2:57347 (MHSMP-77-20)
TATB/THERMAL DEGRADATION
Influence of metals on the thermal decomposition of s-triaminotrinitrobenzene (TATB), 2:57345 (LA-6873-MS)
TEA
See BEVERAGES
TECHNOLOGY ASSESSMENT/ENERGY MODELS
Regional reference energy systems (Projection to year 2000), 2:56948 (EPRI-EA-462)
TECHNOLOGY ASSESSMENT/REGIONAL ANALYSIS
Regional reference energy systems (Projection to year 2000), 2:56948 (EPRI-EA-462)
TECHNOLOGY TRANSFER/MEETINGS
Transactions of the Iran conference on the transfer of nuclear technology held April 10-14, 1977, in Persepolis/Shiraz, Iran, 2:56630
TECHNOLOGY UTILIZATION
Job creation through energy conservation: a solution to a crisis (Massive program of weatherization, etc), 2:56918 (PB-265295)
TELEVISION/USES
Monitoring sinusoidal vibration environments with a television system, 2:57314 (BDX-613-1295(Rev.))
TERRESTRIAL ECOSYSTEMS/BIOLOGICAL MODELS
Effects of substrate type and arsenic dosage level on arsenic behavior in grassland microcosms. Part I. Preliminary results on ^{74}As transport, 2:57380 (CONF-770647-1)
TERRESTRIAL ECOSYSTEMS/RADIONUCLIDE MIGRATION
Effects of substrate type and arsenic dosage level on arsenic behavior in grassland microcosms. Part I. Preliminary results on ^{74}As transport, 2:57380 (CONF-770647-1)
TEXACO GASIFICATION PROCESS/CHEMICAL FEEDSTOCKS
Gasification of residual materials from coal liquefaction. Quarterly report, October-December 1976, 2:55611 (FE-2247-1)
TEXTILE INDUSTRY/ENERGY MANAGEMENT
Energy conservation in dyeing and finishing, 2:56944
Practical meaning of energy management, 2:56943
TEXTILE INDUSTRY/FIBERS
Fibers as renewable resources for industrial materials (Review and assessment), 2:56928 (PB-264561)

TEXTILE INDUSTRY/MATERIALS
Fibers as renewable resources for industrial materials (Review and assessment), 2:56928 (PB-264561)
TEXTILES/DRYING
Radio frequency textile drying, 2:57037
TFTR DEVICE/CRYOPUMPS
Cryopump, neutral-beam compatibility test, 2:57798
TFTR DEVICE/DESIGN
Fusion-driven actinide burner design study. Final report, 2:57755 (EPRI-ER-451(Vol.1)(5-77))
Fusion-driven actinide burner design study. Final report, 2:57756 (EPRI-ER-451(Vol.2)(5-77))
TFTR DEVICE/MAINTENANCE
Some interesting engineering problems in TFTR design, 2:57790
TFTR DEVICE/NUCLEAR ENGINEERING
Physics/engineering interface on the Tokamak Fusion Test Reactor Project, 2:57698
TFTR DEVICE/PLANNING
Industrial subcontractor team looks at TFTR, 2:57697
TFTR DEVICE/RADIOACTIVE WASTE DISPOSAL
Fusion-driven actinide burner design study. Final report, 2:57755 (EPRI-ER-451(Vol.1)(5-77))
Fusion-driven actinide burner design study. Final report, 2:57756 (EPRI-ER-451(Vol.2)(5-77))
TFTR DEVICE/RESEARCH PROGRAMS
Role of the TFTR in the development of tokamak physics, 2:57695
TFTR DEVICE/REVIEWS
Role of TFTR, 2:57694
TFTR: an overview, 2:57696
THALLIUM 201/TISSUE DISTRIBUTION
Biokinetics of Tl-201 in mice after intravenous and oral administration of TlCl, 2:57439 (CONF-770673-1)
THALLIUM 203 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
THALLIUM 205 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
THERMAL EFFLUENTS/MATHEMATICAL MODELS
Analysis of buoyant surface jets, 2:57386
THERMAL ENERGY STORAGE EQUIPMENT/COST
Thermal energy storage using large hollow steel ingots, 2:56161
THERMAL ENERGY STORAGE EQUIPMENT/DESIGN
HYCSOS: a chemical heat pump and energy system based on metal hydrides, 2:57002 (ANL-77-39)
Thermal energy storage by the sulfuric acid-water system, 2:56162
THERMAL ENERGY STORAGE EQUIPMENT/ECONOMICS
Alternative energy transmission systems from OTEC plants. Project 8980 third quarter progress report, January 1-March 31, 1977, 2:56091 (DSE/2426-12)
THERMAL ENERGY STORAGE EQUIPMENT/FEASIBILITY STUDIES
Alternative energy transmission systems from OTEC plants. Project 8980 third quarter progress report, January 1-March 31, 1977, 2:56091 (DSE/2426-12)
Storage of solar energy by inorganic oxide/hydroxides, 2:56163
THERMAL ENERGY STORAGE EQUIPMENT/LATENT HEAT STORAGE
Thermal energy storage with saturated aqueous solutions, 2:56165
THERMAL ENERGY STORAGE EQUIPMENT/MEETINGS
Proceedings of a NATO science committee conference on thermal energy storage (TES), 2:56887
THERMAL ENERGY STORAGE EQUIPMENT/TECHNOLOGY ASSESSMENT
High temperature thermal energy storage (124 references), 2:56154
THERMAL POLLUTION
(Environmental temperature rise due to waste heat disposal)
THERMAL POLLUTION/BIOLOGICAL EFFECTS
The age and growth of the largemouth bass 'Micropterus salmoides' (lacepede), in a thermally loaded reservoir, 2:57441 (PB-264914)
THERMAL POLLUTION/MONITORING
Indiana stream-temperature characteristics. Water-resources investigations (final), 2:57402 (PB-265346)
THERMAL POWER PLANTS
See also GEOTHERMAL POWER PLANTS
THERMAL POWER PLANTS/AIR POLLUTION
Predicted transport of air pollutants from the Navajo and Kaiparowits generating stations into Lake Powell, 2:57359 (PB-265101)
THERMAL POWER PLANTS/BOILERS
Comparative tests of a TP-100 boiler with closed-loop and open-loop systems of p.f. preparation when burning Lvov-Volynian pit coal, 2:56312
Determination of the permissible deflection of boiler headers at steam power plants, 2:56290
Gas and fuel oil boiler unit for an 800 mW power block, 2:56321
Industrial tests of a membrane economizer on a TP-120 boiler at the Saratov No.2 heat-and-power plant, 2:56315
THERMAL POWER PLANTS/CAPACITY
Rational ways of increasing unit capacity of power gas turbine installations constructed according to a simple thermal diagram, 2:56313
THERMAL POWER PLANTS/COAL PREPARATION
Statistical analysis of patents for determination of the world level of development of coal pulverization equipment at steam power plants, 2:55720
THERMAL POWER PLANTS/COOLING SYSTEMS
Overview of economic, legal, and water availability factors affecting the demand for dry and wet/dry cooling for thermal power plants, 2:56237 (BNWL-2268)
THERMAL POWER PLANTS/COOLING TOWERS
Study of the comparative costs of five wet/dry cooling tower concepts, 2:56236 (BNWL-2122)
THERMAL POWER PLANTS/EFFICIENCY
Role of alkali metals in energy conservation, 2:56244 (CONF-760503-P1)
Selection of a rational program of control of high pressure condensing steam turbine power plants, 2:56299
THERMAL POWER PLANTS/ENVIRONMENTAL EFFECTS
Report of a workshop on the impact of thermal power plant cooling systems on aquatic environments, Asilomar, Pacific Grove, California, September 28-October 2, 1975. Volume I. Working group results, 2:57401 (EPRI-SR-38(Vol.1))
THERMAL POWER PLANTS/GAS TURBINES
Rational ways of increasing unit capacity of power gas turbine installations constructed according to a simple thermal diagram, 2:56313
THERMAL POWER PLANTS/GASEOUS WASTES
Ways to reduce atmospheric pollution in cities by fuel combustion products, 2:56348
THERMAL POWER PLANTS/MATHEMATICAL MODELS
Utilization of exergy function in mathematical modeling of thermal power plants, 2:56233
THERMAL POWER PLANTS/OFF-PEAK ENERGY STORAGE
Storage of steam in off-peak periods for application during peak demands, 2:56343
THERMAL POWER PLANTS/PERFORMANCE TESTING
Multifactorial model of technical and economic indices of performance of thermal power plants, 2:56232
THERMAL POWER PLANTS/PIPES
Permissible value of compensation stresses in piping systems of power plants, operating in creep conditions, 2:56289
Ways to solve the problem of extending the service life of existing and projected steam pipelines beyond 100,000 hr, 2:57122
Working capacity and reliability of pipes made of steel 12Cr1MoV after long periods of operations, 2:57123
THERMAL POWER PLANTS/POLLUTION CONTROL EQUIPMENT
Report of the Hearing Panel: National Public Hearing on Power Plant Compliance with Sulfur Oxide Air Pollution Regulations, conducted October 18, 1973 through November 2, 1973, 2:56346 (PB-264891)
THERMAL POWER PLANTS/PRESSURE VESSELS
Analysis of residual stresses/strains in pressure vessels due to cyclic thermomechanical loads, 2:56281
Pressure vessel technology. I. Analysis, design, and inspection, 2:56667
Pressure vessel technology. II. Materials and fabrication, 2:56671
THERMAL POWER PLANTS/REFUSE DERIVED FUELS
Incineration of domestic refuse: experience in Germany, 2:56247
Incineration of domestic refuse: refuse into energy at Sheffield, 2:56248
Incineration of domestic refuse: power from refuse at Kynoch works, 2:56249
THERMAL POWER PLANTS/SIZE
Selection of the reasonable standard size and profile of power blocks for central Siberian conditions, 2:56316
THERMAL POWER PLANTS/STEAM LINES
Permissible value of compensation stresses in piping systems of power plants, operating in creep conditions, 2:56289
THERMAL POWER PLANTS/STEAM TURBINES
Means for extending the service life of the metal of high-temperature elements of high-capacity power units, 2:57121
THERMAL POWER PLANTS/THERMAL EFFLUENTS
Analysis of buoyant surface jets, 2:57386
Indiana stream-temperature characteristics. Water-resources investigations (final), 2:57402 (PB-265346)
THERMAL POWER PLANTS/THERMAL ENERGY STORAGE EQUIPMENT
Storage of steam in off-peak periods for application during peak demands, 2:56343
THERMAL POWER PLANTS/TOPPING CYCLES
Role of alkali metals in energy conservation, 2:56244 (CONF-760503-P1)

THERMAL POWER PLANTS/VAPOR CONDENSATION
Heat transfer during steam condensation on tube bundles of alternating slope and different directions of flow supply, 2:56301
THERMAL REACTORS
See also BLACK FOX-1 REACTOR
BLACK FOX-2 REACTOR
NEP-1 REACTOR
THERMAL REACTORS/COMPARATIVE EVALUATIONS
Comparative breeding characteristics of fusion and fast reactors, 2:57748
THERMAL REACTORS/FUEL CYCLE
Impact of thermal near-breeders on uranium utilization, 2:56600
THERMAL REACTORS/REACTOR MATERIALS
Isotopically tailored materials for fission and fusion reactors, 2:56652 (MLM-2426(OP))
THERMAL SPRINGS
See also HOT SPRINGS
THERMAL SPRINGS/GEOCHEMICAL SURVEYS
Subsuperficial changes in chemical composition of the thermomineral waters of Vichy basin. Geothermal implications, 2:56193
THERMAL WATERS/CHEMICAL COMPOSITION
Antimony content in the hot spring waters in Gunma Prefecture, 2:56190
Boric acid content of hot springs and river waters at Owakudani Valley, Volcano Hakone, 2:56192
Calcium chloride springs of sea water origin in Toi Hot Spring, 2:56191
Determination of trace elements in hot spring water by anode stripping voltametry, 2:56211
Subsuperficial changes in chemical composition of the thermomineral waters of Vichy basin. Geothermal implications, 2:56193
THERMAL WATERS/GEOTHERMOMETRY
Subsuperficial changes in chemical composition of the thermomineral waters of Vichy basin. Geothermal implications, 2:56193
THERMAL WATERS/TEMPERATURE MEASUREMENT
Observation of temperature and water level in Hakone volcano, 1973, 2:56179
Procedure for estimating the temperature of a hot-water component in a mixed water by using a plot of dissolved silica versus enthalpy, 2:56209
THERMOCHEMICAL HEAT STORAGE
Ammonium hydrogen sulfate decomposition for storage of energy for electrical power generation, 2:56152
Storage of solar energy by inorganic oxide/hydroxides, 2:56163
Thermal storage by paired ammoniated salts, 2:56151
THERMOCHEMICAL HEAT STORAGE/COST
Thermal energy storage by the sulfuric acid-water system, 2:56162
THERMOCHEMICAL HEAT STORAGE/DESIGN
Thermal energy storage by the sulfuric acid-water system, 2:56162
THERMOCHEMICAL HEAT STORAGE/MATERIALS
Reversible oxidation of metal oxides for thermal energy storage, 2:56164
THERMOCHEMICAL HEAT STORAGE/REVIEWS
Chemical methods of storing thermal energy, 2:56155
THERMOCOUPLES/DESIGN
Determination of the effective depth of hot junction of surface thermocouples when investigating nonsteady heat transfer in an internal combustion engine, 2:57052
THERMOCOUPLES/ERRORS
Derivation and testing of a model to calculate electrical shunting and leakage errors in sheathed thermocouples, 2:57342
THERMOCOUPLES/HEAT TRANSFER
Calculation of the parameters of a radiant flux receiver, taking into account its exchange with the environment, 2:56024
THERMOCOUPLES/PERFORMANCE
Comparison of a thermopile broadband detector and a photon detector for the measurement of solar radiation. Part I. Analysis of simultaneous data. Part II. Cosine response functions, 2:56022 (PB-265282)
THERMOMETERS/DESIGN
Passive electronic identification and temperature monitoring system. Progress report, January-December 1976 (For monitoring temperature in livestock), 2:57340 (LA-6812-PR)
THERMONUCLEAR DEVICES
See also FM DEVICES
ORMAK DEVICES
TOKAMAK DEVICES
THERMONUCLEAR DEVICES/PHYSICAL RADIATION EFFECTS
Method and means of reducing erosion of components of plasma devices exposed to helium and hydrogen isotope radiation (Patent), 2:57803
THERMONUCLEAR FUELS/BEAM INJECTION
Fueling by high-speed pellet injection, 2:57750
THERMONUCLEAR FUELS/TEST FACILITIES
Tritium systems test assembly at Los Alamos Scientific Laboratory, 2:57753
THERMONUCLEAR IGNITION/SLOWING-DOWN
Application of a unified slowing-down theory to fusion plasmas, 2:57648
THERMONUCLEAR REACTIONS/COMPUTER CODES
Computation of specific thermonuclear reaction rates: the STEEP Code, 2:57754
THERMONUCLEAR REACTIONS/INFORMATION SYSTEMS
Time for atomic and molecular data bases is now (an overview of data management research at LLL), 2:57832 (UCRL-79286)
THERMONUCLEAR REACTOR COOLING SYSTEMS
Comparative study of exploratory reactor concepts for inertial confinement fusion, 2:57779
Liquid-lithium waterfall inertial confinement fusion reactor concept, 2:57747
THERMONUCLEAR REACTOR COOLING SYSTEMS/DESIGN
Laser fusion hybrid reactor systems study, 2:57769 (UCRL-13720)
THERMONUCLEAR REACTOR COOLING SYSTEMS/HEAT TRANSFER
Conduction-cooled minimum activity blankets for TNS and EPR fusion reactors, 2:57746
THERMONUCLEAR REACTOR COOLING SYSTEMS/LOSS OF COOLANT
Blanket cooling under accident conditions in fusion-fusion hybrid power reactors, 2:57743
THERMONUCLEAR REACTOR MATERIALS/CLEANING
Radiation cleanup of vacuum systems (radiation-induced outgassing). Progress report, September 15, 1976-September 14, 1977, 2:57787 (COO-4093-1)
THERMONUCLEAR REACTOR MATERIALS/MATERIALS TESTING
New approach to assessing fusion plasma-materials interactions, 2:57789
THERMONUCLEAR REACTOR MATERIALS/PERMEABILITY
Some perspective on tritium permeation in fusion reactors based on existing data and experience, 2:57760
THERMONUCLEAR REACTOR MATERIALS/PHYSICAL RADIATION EFFECTS
Systematic approach to the radiation damage problem in fission and fusion reactor structural alloys, 2:57143 (UWFDM-184)
THERMONUCLEAR REACTOR WALLS
See also FIRST WALL
THERMONUCLEAR REACTOR WALLS/MATERIALS TESTING
High-current plasma accelerator for the investigation of plasma wall interaction, 2:57654
THERMONUCLEAR REACTOR WALLS/PLATING
Coatings application for fusion research, 2:57099
THERMONUCLEAR REACTOR WALLS/SPUTTERING
Laboratory sputtering studies in fusion research, 2:57723
THERMONUCLEAR REACTORS
(For use in cases where certain aspects of either hypothetical or real thermonuclear reactors are discussed.)
See also D-T REACTORS
E-BEAM TYPE REACTORS
I-BEAM TYPE REACTORS
LASER FUSION REACTORS
MAGNETIC MIRROR TYPE REACTORS
REFERENCE THETA PINCH REACTOR
THERMONUCLEAR REACTOR WALLS
TOKAMAK TYPE REACTORS
THERMONUCLEAR REACTORS/ATOM-ATOM COLLISIONS
Atomic physics in the controlled thermonuclear research program, 2:57646
THERMONUCLEAR REACTORS/BIBLIOGRAPHIES
Technology index for plasmaphysics research and fusion reactors. Volume 11, No. 6, 1977. Bibliography, author index, subject index, appendix, 2:57626
Technology index for plasmaphysics research and fusion reactors. Volume 11, No. 5, 1977. Bibliography, author index, subject index, appendix, 2:57627
THERMONUCLEAR REACTORS/COST
Cost components of fusion plant design, 2:57704
Standard fusion reactor costing methods, 2:57703
THERMONUCLEAR REACTORS/CRYOPUMPS
Cryopumping of deuterium hydrogen and helium mixtures on smooth 4.2 K surfaces, 2:57785 (BNL-22759)
Cryosorption pumping of helium at 4.2 K by Type 5A molecular sieve, 2:57797
THERMONUCLEAR REACTORS/DEMONSTRATION PLANTS
Nuclear power industry in the tenth five-year plan period, 2:56390

THERMONUCLEAR REACTORS/DESIGN
Recent developments in the design of conceptual fusion reactors, 2:57693
THERMONUCLEAR REACTORS/ECONOMIC DEVELOPMENT
Economic analysis of commercial fusion power, 2:57699
Economic approaches to long-term energy source selection, 2:57700
THERMONUCLEAR REACTORS/ENERGY DEMAND
Potential need for fusion in the U.S. energy system, 2:57702
THERMONUCLEAR REACTORS/ENERGY STORAGE
Economic feasibility of a fusion-based energy storage system, 2:57741
THERMONUCLEAR REACTORS/ENVIRONMENTAL EFFECTS
Overview of the MFE/ERDA Environment and Safety Program, 2:57757
THERMONUCLEAR REACTORS/ENVIRONMENTAL IMPACTS
Biological implications of magnetic fields from fusion reactors, 2:57759
THERMONUCLEAR REACTORS/IMPURITIES
Laboratory sputtering studies in fusion research, 2:57723
THERMONUCLEAR REACTORS/ION-ATOM COLLISIONS
Atomic physics in the controlled thermonuclear research program, 2:57646
THERMONUCLEAR REACTORS/LOSS OF COOLANT
Loss-of-coolant accidents in lithium-cooled fusion blankets, 2:57744
THERMONUCLEAR REACTORS/MAGNET COILS
Kinetic energy release in missile ejection from confining magnets, 2:57733
THERMONUCLEAR REACTORS/NEUTRON SPECTRA
High-Z spectral shifter in a fusion reactor, 2:57726
THERMONUCLEAR REACTORS/PLASMA CONFINEMENT
Determination of plasma parameters in a fusion system, 2:57634
THERMONUCLEAR REACTORS/RADIATION HAZARDS
Tritium containment and cleanup technology in the Tritium Systems Test Assembly, 2:57758
THERMONUCLEAR REACTORS/RADIOACTIVATION
DKR: a radioactivity calculation code and decay chain data library, 2:57792
THERMONUCLEAR REACTORS/RADIOACTIVE WASTE DISPOSAL
Initial neutronic evaluation of imploding liner fusion reactor blankets for transmuting fission products, 2:57796
Waste management procedures for CTR central power stations, 2:57762
THERMONUCLEAR REACTORS/RADIOACTIVITY
Minimizing long-term radioactivity in fusion reactors by isotopic tailoring, 2:57791
THERMONUCLEAR REACTORS/RELEASE LIMITS
Tritium health effects during normal and off-normal release in CTRs, 2:57763
THERMONUCLEAR REACTORS/SAFETY
Overview of the MFE/ERDA Environment and Safety Program, 2:57757
Safety studies of second-generation fusion reactor designs, 2:57761
THERMONUCLEAR REACTORS/SCALING LAWS
Determination of plasma parameters in a fusion system, 2:57634
THERMONUCLEAR REACTORS/SHIELDING
Where are we and where are we going in reactor shielding, 2:56651 (CONF-770401-5)
THERMONUCLEAR REACTORS/SUPERCONDUCTING MAGNETS
Applications of superconducting magnets to energy with particular emphasis on fusion power, 2:57740
Lateral buckling and vibrations of superconducting magnets for magnetic fusion reactors. Progress report, October 1976-May 1977, 2:57731 (COO-2780-3)
Safety of large fusion magnet systems, 2:57732
THERMONUCLEAR REACTORS/USES
Radiolytic production of chemical fuels in fusion reactor systems, 2:57786 (COO-3028-28)
THERMONUCLEAR REACTORS/WALL LOADING
High-Z spectral shifter in a fusion reactor, 2:57726
THERMOPHOTOVOLTAIC CONVERTERS/FEASIBILITY STUDIES
Silicon photovoltaic cells in thermophotovoltaic conversion. Progress report, 2:56030 (EPRI-ER-478)
THERMOPHOTOVOLTAIC CONVERTERS/PERFORMANCE TESTING
Silicon photovoltaic cells in thermophotovoltaic conversion. Progress report, 2:56030 (EPRI-ER-478)
THERMOPLASTICS/DEGASSING
Organics used in microelectronics: a review of outgassing materials and effects, 2:57173 (SAND-76-5854C)
THIO COMPOUNDS
See ORGANIC SULFUR COMPOUNDS
THIOETHERS
See SULFIDES
THORIUM/GAMMA SPECTROSCOPY
Uranium, thorium, and potassium content of Precambrian rocks, Upper Peninsula of Michigan and northern Wisconsin. Supplement to GJBX-48(76). Uranium and thorium occurrences in Precambrian rocks, Upper Penninsula of Michigan and northern Wisconsin, with thoughts on other possible settings, 2:57196 (GJBX-43(77))
THORIUM 232/RADIOECOLOGICAL CONCENTRATION
Concentrations of radionuclides and selected stable elements in fruits and vegetables, 2:57381 (CONF-770676-1)
THORIUM CARBIDES/SURFACE COATING
Fuel particles with coatings without property gradients (Patent), 2:55869
THORIUM OXIDES/CASTING
Space Processing Applications Rocket project, SPAR 1. Final report, 2:57093 (N-77-16082)
THORIUM OXIDES/PHYSICAL PROPERTIES
Material compatibility studies for PAHR incore molten pool experiments, 2:56838
THORIUM OXIDES/SURFACE COATING
Fuel particles with coatings without property gradients (Patent), 2:55869
THORIUM OXIDES/WETTABILITY
Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R-1746)
THTR-300 REACTOR/COOLING TOWERS
Air supplants water at Schmehausen, 2:56448
Schmehausen cable net cooling tower, 2:56449
THTR-300 REACTOR/PRESSURE VESSELS
Liner design and construction for the thorium-cooled high-temperature reactor and the safety containment at the Gundremmingen-2 nuclear power plant, 2:56375
TIDAL POWER PLANTS/LOAD MANAGEMENT
Tidal energy and system planning, 2:56215
TIDAL POWER PLANTS/PLANNING
State of the art, 2:56216
TIN/X-RAY FLUORESCENCE ANALYSIS
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57198 (LA-6869-MS)
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57197 (LA-6869)
TIN ALLOYS
See also BRONZE
TIN ALLOYS/PHYSICAL RADIATION EFFECTS
Mechanism for the degradation of superconducting transition temperatures on high energy neutron radiation in A-15 compounds, 2:57125 (BNL-23053)
TIN ALLOYS/TENSILE PROPERTIES
Influence of tensile stresses on the superconducting temperature of multifilamentary Nb_3Sn composite conductors, 2:57107 (BNL-23016)
TIN ALLOYS/TRANSITION TEMPERATURE
Influence of tensile stresses on the superconducting temperature of multifilamentary Nb_3Sn composite conductors, 2:57107 (BNL-23016)
Mechanism for the degradation of superconducting transition temperatures on high energy neutron radiation in A-15 compounds, 2:57125 (BNL-23053)
TISSUES
See also EPITHELIUM
TISSUES/RADIONUCLIDE KINETICS
Biokinetics of Tl-201 in mice after intravenous and oral administration of TlCl, 2:57439 (CONF-770673-1)
TITANIUM/NEUTRON REACTIONS
Comments on the energy-averaged total neutron cross sections of structural materials in the few MeV range, 2:57591 (ANL/NDM-33)
TITANIUM 47 TARGET/DEUTERON REACTIONS
Reactions $^{47}Ti(d,p)^{48}Ti$ and $^{49}Ti(d,p)^{50}Ti$ at a deuteron energy 13.6 MeV (Differential cross sectios, DWBA, Hauser-Feshbach theory), 2:57595
TITANIUM 48/ENERGY LEVELS
Reactions $^{47}Ti(d,p)^{48}Ti$ and $^{49}Ti(d,p)^{50}Ti$ at a deuteron energy 13.6 MeV, 2:57595
TITANIUM 49 TARGET/DEUTERON REACTIONS
Reactions $^{47}Ti(d,p)^{48}Ti$ and $^{49}Ti(d,p)^{50}Ti$ at a deuteron energy 13.6 MeV (Differential cross sectios, DWBA, Hauser-Feshbach theory), 2:57595
TITANIUM 50/ENERGY LEVELS
Reactions $^{47}Ti(d,p)^{48}Ti$ and $^{49}Ti(d,p)^{50}Ti$ at a deuteron energy 13.6 MeV, 2:57595
TITANIUM ALLOYS/AGING
Characterization and aging kinetics study of gamma prime strengthened Fe-Cr-Ni experimental alloys for breeder reactors, 2:57119 (WARD-AD-3045-5)
TITANIUM ALLOYS/QUENCHING
Effects of rapid quenching of superconductors, 2:57096

TITANIUM ALLOYS/STRESS CORROSION
Stress-corrosion studies on materials used for surgical implants (T318), 2:57138
TITANIUM ALLOYS/TRANSITION TEMPERATURE
Effects of rapid quenching of superconductors, 2:57096
TITANIUM CARBIDES/WETTABILITY
Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R-1746)
TITANIUM NITRIDES/QUENCHING
Effects of rapid quenching of superconductors, 2:57096
TITANIUM NITRIDES/TRANSITION TEMPERATURE
Effects of rapid quenching of superconductors, 2:57096
TITANIUM OXIDES/ELECTRONIC STRUCTURE
Significant differences between Hartree-Fock and local-exchange energy bands for TiO, 2:57158
TITANIUM OXIDES/PHASE TRANSFORMATIONS
Titanium-oxygen system: review of structure, thermodynamics, and phase equilibria, 2:57154 (UCRL-13726)
TOBACCO/SOLAR DRYING
Solar energy applications in agriculture: potential, research needs, and adoption strategies, 2:56092 (PB-265105)
TOBACCO PRODUCTS/DENSITY
Density measurements in a burning cigarette, 2:57339
TOBACCO SMOKES/DENSITY
Density measurements in a burning cigarette, 2:57339
TOKAMAK DEVICES
See also PLT DEVICES
TFTR DEVICE
TOKAMAK DEVICES/CONVECTIVE INSTABILITIES
Neutral beam driven convective loss cone instability in toroidal geometry, 2:57670
TOKAMAK DEVICES/FIRST WALL
First-wall characterization of tokamaks by in situ auger electron spectroscopy, 2:57801
TOKAMAK DEVICES/IMPURITIES
Local diagnostics of impurity ions in a hot plasma, 2:57637
TOKAMAK DEVICES/KINK INSTABILITY
Experimental and numerical studies of magnetohydrodynamic stability properties of a rectangular-cross-section finite-β toroidal plasma, 2:57671
TOKAMAK DEVICES/LOSS CONE INSTABILITY
Neutral beam driven convective loss cone instability in toroidal geometry, 2:57670
TOKAMAK DEVICES/PLASMA DIAGNOSTICS
Local diagnostics of impurity ions in a hot plasma, 2:57637
TOKAMAK DEVICES/PLASMA DRIFT
Wave analysis of the tokamak drift mode, 2:57682
TOKAMAK DEVICES/SUPERCONDUCTING MAGNETS
Applications of superconducting magnets to energy with particular emphasis on fusion power, 2:57740
TOKAMAK TYPE REACTORS/DESIGN
Detailed design features of a high-field compact tokamak reactor (HFCTR), 2:57716
Impact of key plasma parameters on tokamak reactor designs, 2:57717
Superconducting toroidal field magnets for a tokamak engineering test reactor, 2:57739
TOKAMAK TYPE REACTORS/DIVERTORS
Divertors for impurity control in tokamaks, 2:57722
TOKAMAK TYPE REACTORS/ECONOMICS
Impact of major design parameters on economics of Tokamak Power Plants, 2:57705
Parametric and economic analysis of tokamak reactors with elongated plasmas, 2:57708
TOKAMAK TYPE REACTORS/IMPURITIES
Divertors for impurity control in tokamaks, 2:57722
Impurity models for tokamaks, 2:57724
Low Z/sub eff/ tokamak operation, 2:57721
Measurements of the concentrations of impurities in tokamaks, 2:57720
Modeling and analysis of impurity control techniques for tokamak fusion reactors, 2:57800
TOKAMAK TYPE REACTORS/MAGNET COILS
Advantages of nonuniform current density distribution in an ohmic heating coil, 2:57736
TOKAMAK TYPE REACTORS/MAGNETIC FIELD CONFIGURATIONS
Positional instabilities of a plasma in a tokamak with a magnetic limiter, 2:57737
TOKAMAK TYPE REACTORS/MAINTENANCE
MAXAMAK and MULTIMAK: new approaches for tokamak power reactors, 2:57715
TOKAMAK TYPE REACTORS/MEETINGS
Plasma physics and controlled nuclear fusion research, 1976. Nuclear fusion, supplement 1977. Volume I, 2:57687 (STI/PUB-439(Vol.1))
Plasma physics and controlled nuclear fusion research, 1976. Nuclear fusion, supplement 1977. Volume II, 2:57688 (STI/PUB-439(Vol.2))
Plasma physics and controlled nuclear fusion research, 1976. Nuclear fusion, supplement 1977. Volume III, 2:57689 (STI/PUB-439(Vol.3))
TOKAMAK TYPE REACTORS/MULTI-CHANNEL ANALYZERS
10-channel neutral particle energy analyser for measurements of ion temperatures on tokamak plasmas, 2:57642
TOKAMAK TYPE REACTORS/PLANNING
TNS scoping studies, 2:57706
TOKAMAK TYPE REACTORS/PLASMA DRIFT
Time reduction techniques for neutral atom transport by multigroup methods, 2:57649
TOKAMAK TYPE REACTORS/PLASMA MICROINSTABILITIES
Microinstability theory in tokamaks: a review, 2:57664 (PPPL-1354)
TOKAMAK TYPE REACTORS/REVIEWS
Magnetic fusion energy (Lectures on status of tokamak and magnetic mirror research), 2:57691 (UCRL-79600)
Nuclear fusion: focus on tokamak, 2:57692
TOKAMAK TYPE REACTORS/SUPERCONDUCTING MAGNETS
Cryogenic instrumentation needs in the controlled thermonuclear research program, 2:57738
Superconducting toroidal field magnets for a tokamak engineering test reactor, 2:57739
TOKAMAK TYPE REACTORS/TEMPERATURE MEASUREMENT
10-channel neutral particle energy analyser for measurements of ion temperatures on tokamak plasmas, 2:57642
TOKAMAK TYPE REACTORS/THERMONUCLEAR FUELS
Fueling by high-speed pellet injection, 2:57750
Fueling of toroidal plasmas by ripple-assisted injection of energetic particles, 2:57751
Fueling problem, 2:57749
TOKAMAK TYPE REACTORS/THERMONUCLEAR IGNITION
D-^{3}He-fueled tokamak power reactors, 2:57752
TOKAMAK TYPE REACTORS/TRANSPORT THEORY
Time reduction techniques for neutral atom transport by multigroup methods, 2:57649
TOLUENE/SOLVENT PROPERTIES
Oxidations of coal, coal fractions, and coal models (9 refs), 2:55637 (CONF-760885-)
TOMOGRAPHY/IMAGE PROCESSING
Fast iterative method for 3-D positron image reconstruction, 2:57425
TONOPAH TEST RANGE/RADIATION MONITORING
Ratio estimation techniques in the analysis of environmental radionuclide data, 2:57379 (BNWL-SA-5975(Rev.))
TOPPING CYCLES/EFFICIENCY
Role of alkali metals in energy conservation, 2:56244 (CONF-760503-P1)
TOTAL ENERGY SYSTEMS/SOLAR ENERGY
Industrial applications of solar energy. Quarterly report, 2:56093 (SAN/1132-1)
Sandia's solar total energy program, 2:56099 (SAND-75-5880)
TOWER FOCUS POWER PLANTS/DESIGN
Tower design considerations for the solar thermal central receiver systems, 2:56086 (SAND-77-8243)
TOWER FOCUS POWER PLANTS/LATENT HEAT STORAGE
Inorganic phase change materials for energy storage in solar thermal program ($NaNO_3$ and NaOH mixture), 2:56158
TOWER FOCUS POWER PLANTS/MECHANICAL STRUCTURES
Tower design considerations for the solar thermal central receiver systems, 2:56086 (SAND-77-8243)
TOWER FOCUS POWER PLANTS/PILOT PLANTS
Coming: solar power plants (10-MW/sub e/), 2:56087
TOWER FOCUS POWER PLANTS/SEISMIC EFFECTS
Tower design considerations for the solar thermal central receiver systems, 2:56086 (SAND-77-8243)
TOWN GAS/PRODUCTION
North Thames shuts down last gas-making station, 2:55991
TOXIC MATERIALS/BIBLIOGRAPHIES
Toxicology Information Response Center literature search index, June 1976-May 1977. III. 2601-3100, 2:57445 (ORNL/TIRC-77/6)
TOXIC MATERIALS/DATA COMPILATION
Toxicology Information Response Center literature search index, June 1976-May 1977. III. 2601-3100, 2:57445 (ORNL/TIRC-77/6)
TOXIC MATERIALS/HAZARDS
Relative hazard of nuclear wastes and naturally occurring toxic minerals, 2:55952
TRACER TECHNIQUES
Argonne Bioanalytical Center: a resource for collaborative biomedical applications of stable isotopes, 2:57407 (CONF-761234-3)

TRACER TECHNIQUES/TECHNOLOGY ASSESSMENT
Some practical experiences using sulphur hexafluoride as a tracer gas to determine leakage rates in mine ventilation systems, mainly in the South Nottinghamshire area, 2:55680
TRACHEA/CARCINOGENESIS
Organ culture-cell culture system for studying multistage carcinogenesis in respiratory epithelium (Mice), 2:57453 (CONF-770342-2)
TRAINING
See EDUCATION
TRAINS
See also ELECTRIC RAILWAYS
Technical feasibility study of railroad electrification with high voltage (10-50 kV) direct current. Final report, Jan-Jun 1976, 2:57065 (PB-265018)
TRAINS/DESIGN
Bo'bo' motor-coaches for the Ferrocarriles Guadarrama in Spain, 2:57028
Experimental 3000 v d.c. locomotive of the Italian state railways with chopper control, 2:57027
TRAINS/FLYWHEEL ENERGY STORAGE
Flywheels: energy saving way to go, 2:57071
TRAINS/PERFORMANCE TESTING
Trolley-wire-operated underground locomotive with manual and remote control, including fully automatic control and speed regulation, 2:55706
TRANS 104 ELEMENTS/NUCLEOSYNTHESIS
Search for superheavy elements in the bombardment of ^{248}Cm with ^{48}Ca, 2:57601
TRANSDUCERS/PERFORMANCE
Helium research in support of superconducting power transmission. Annual report, July 1975-September 1976, 2:56360 (CONS/3800-1)
TRANSFER (HEAT)
See HEAT TRANSFER
TRANSIENT REACTOR TEST FACILITY
See TREAT REACTOR
TRANSITION ELEMENT COMPLEXES/CATALYTIC EFFECTS
Contribution to the chemistry of oligo-olefins, 2:55773
TRANSITION ELEMENT COMPOUNDS/PHASE TRANSFORMATIONS
Optical absorption of VO_2 and V_2O_3 films and ability to predict semiconductor-semimetal phase transitions in transition metal compounds, 2:57160
TRANSITIONS (PHASE)
See PHASE TRANSFORMATIONS
TRANSPORT REGULATIONS
Transportation regulatory revisions, 2:55887
TRANSPORTATION SECTOR/ENERGY CONSERVATION
Organizing and operating a vanpool program: feasibility of vanpooling in Virginia. Final report, 2:56940 (PB-264635)
TRANSPORTATION SYSTEMS/ECONOMICS
Ton-mile, does it properly measure transportation output, 2:57023
TRANSPORTATION SYSTEMS/EVALUATION
Small bus program: vehicle operation efficiency report. Part I. experimental bus program (15-20 passenger buses). Part II. Van conversions for dial-a-ride service (12 passenger buses), 2:56941 (PB-265131)
TRANSPORTATION SYSTEMS/NUCLEAR MATERIALS MANAGEMENT
Evaluation of safeguards systems for nuclear material in transit: the development of the program plan. Winter 1977 quarterly report, 2:55964 (SAND-77-8249)
TRANSPORTATION SYSTEMS/OPTIMIZATION
Integrated method of determination of optimal reliability indices of the transportation and technological network of a coal mine, 2:55707
TRANSPORTATION SYSTEMS/RELIABILITY
Integrated method of determination of optimal reliability indices of the transportation and technological network of a coal mine, 2:55707
TRANSPORTATION SYSTEMS/RESEARCH PROGRAMS
Principal tasks and lines of development in higher educational establishments of studies concerning transportation in coal mines in the tenth five-year plan period, 2:55721
TRANSURANIUM ELEMENTS
See also PLUTONIUM
TRANSURANIUM ELEMENTS/ENVIRONMENTAL TRANSPORT
Ratio estimation techniques in the analysis of environmental radionuclide data, 2:57379 (BNWL-SA-5975(Rev.))
TRAPPED ELECTRONS/ABSORPTION SPECTRA
Comparison of photoconductivity and optical spectra of the trapped electron in polar aqueous and alcoholic glasses, 2:57238
TRAPPED ELECTRONS/PHOTOCONDUCTIVITY
Comparison of photoconductivity and optical spectra of the trapped electron in polar aqueous and alcoholic glasses, 2:57238
TREAT REACTOR/REACTOR SAFETY EXPERIMENTS
Time series analysis and forecasting applied to ANL TREAT experiments, 2:56815
TRITIUM/CONTAINMENT
Tritium containment and cleanup technology in the Tritium Systems Test Assembly, 2:57758
TRITIUM/DIFFUSION
Behaviour of tritium in a graphite reactor, 2:56441
Mathematical models for transport of tritium and helium-4 in solid breeders, 2:57765
Some perspective on tritium permeation in fusion reactors based on existing data and experience, 2:57760
TRITIUM/DOSIMETRY
Assessment of potential radiation dose-to-man from an acute tritium release into a forest ecosystem, 2:57382 (DP-MS-76-89)
TRITIUM/IMPURITIES
Methane formation in tritium gas exposed to stainless steel, 2:55968 (UCRL-52262)
TRITIUM/MATERIALS HANDLING
Role of the engineer in protecting personnel and the environment in the nuclear industry, 2:57273 (MLM-2438(OP))
TRITIUM/RADIATION MONITORING
Sensitive method for continuous air monitoring for ^{14}C and ^{3}H, 2:57374 (MLM-2441(TR))
TRITIUM/RADIOACTIVE WASTE PROCESSING
Immobilization of tritiated aqueous waste in polymer-inpregnated concrete, 2:55905
TRITIUM/RELEASE LIMITS
Tritium health effects during normal and off-normal release in CTRs, 2:57763
TRITIUM/REMOVAL
Assessment of uranium and cerium as hydriding materials for hydrogen isotopes in flowing argon, 2:57799
TRITIUM/TEST FACILITIES
Tritium systems test assembly at Los Alamos Scientific Laboratory, 2:57753
TRITIUM IONS/COLLISIONS
Trapping efficiency of molten lithium for 20-keV tritium ions, 2:57497
TRITIUM IONS/TRAPPING
Trapping efficiency of molten lithium for 20-keV tritium ions, 2:57497
TUBES
(For objects of tubular shape; not for DRIFT TUBES, ELECTRON TUBES or IMAGE STORAGE TUBES.)
TUBES/CREEP
Creep properties of electric resistance welded boiler tubes under internal pressure, 2:57261
TUBES/FAILURES
Analysis and prediction of failure in tubes, 2:57257
Creep properties of electric resistance welded boiler tubes under internal pressure, 2:57261
TUBES/MECHANICAL VIBRATIONS
Mathematical model for cross-flow-induced vibrations of tube rows, 2:57255
TUBES/STRESS ANALYSIS
Analysis and prediction of failure in tubes, 2:57257
TUBES (CONDUITS)
See PIPES
TUMORS
See NEOPLASMS
TUNA/THERMOREGULATION
Magnitude and ecological implications of thermal inertia in skipjack tuna, Katsuwonus pelamis (Linnaeus), 2:57444
TUNGSTEN/ION COLLISIONS
Model of secondary electron yields from atomic and polyatomic ion impacts on copper and tungsten surfaces based upon stopping-power calculations, 2:57495
TUNGSTEN/PHYSICAL PROPERTIES
Material compatibility studies for PAHR incore molten pool experiments, 2:56838
TUNGSTEN/X-RAY FLUORESCENCE ANALYSIS
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57198 (LA-6869-MS)
Automated energy-dispersive x-ray determination of trace elements in stream sediments, 2:57197 (LA-6869)
TUNGSTEN 182 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
TUNGSTEN 184 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
TUNGSTEN 186 TARGET/ALPHA REACTIONS
Fission of preactinide nuclei. Angular anisotropy of the (α, f) reaction (30 to 50 MeV), 2:57600
TUNGSTEN ALLOYS
See also STELLITE

TUNGSTEN ALLOYS/CATALYTIC EFFECTS
Surface and electrocatalytic properties of tungsten bronzes, 2:57129 (IS-M-96)
TUNGSTEN ALLOYS/COMPATIBILITY
Compatibility of bismuth and bismuth-lithium solutions with refractory metals and graphite, 2:57108 (CONF-760503-P2)
TUNNELS/CONSTRUCTION
Major rock excavations at Dinorwic, Wales, 2:56004
TUNNELS/DEFORMATION
Model studies of mine roadway deformation, 2:55679
TUNNELS/FOUNDATIONS
Experimental study on roadway swelling in coal mines--1. Effect of roadway depth on swelling (6 refs), 2:55668
TUNNELS/SUPPORTS
Experimental study on roadway swelling in coal mines--1. Effect of roadway depth on swelling (6 refs), 2:55668
TURBINE BLADES/AERODYNAMICS
Rational ways of increasing unit capacity of power gas turbine installations constructed according to a simple thermal diagram, 2:56313
TURBINE BLADES/COMPUTER-AIDED DESIGN
Automation of drawing and graphic work in turbine construction, 2:56339
Cooling of gas turbines blades, 2:56263
Use of computers for aerodynamic calculations in designing a turbine stage with long blades, 2:56317
TURBINE BLADES/COOLING
Cooling of gas turbines blades, 2:56263
Pressure loss coefficient of impingement cooled leading edge system of a turbine blade, 2:56308
TURBINE BLADES/CREEP
Evaluation of concentration of stresses in creep conditions with nonsimple loading, 2:56337
TURBINE BLADES/DEPOSITS
Problem of formation of salt deposits and their effect on physical processes in flow-through parts of turbines, 2:56298
TURBINE BLADES/DESIGN
Design criteria of turbine twisted blading, 2:56283
Effect of small geometric deviations of the shape of rotor blades of hydraulic turbines on their hydraulic qualities and cavitation erosion, 2:56005
Experience with gas turbines fired with blast-furnace gas, 2:56267
Investigation of a stage with a small d/sub av$/l/sub blade/ ratio and lowered radial gradient of the degree of reactivity, 2:56305
Synthesis of optimal design of variable-section rotor blades, 2:56320
TURBINE BLADES/FABRICATION
Stamping unique blades from titanium alloys, 2:56275
TURBINE BLADES/FASTENERS
Rotor for wind-driven machine (Patent), 2:56223
TURBINE BLADES/MECHANICAL VIBRATIONS
Experience of vibrational detuning of blading, 2:56274
Experimental investigation of the effect of frequency nonuniformity on the level of resonance vibrations of rotor blades, 2:56326
Measuring vibration on turbine blades by optical means, 2:56266
TURBINE BLADES/STRESS ANALYSIS
Evaluation of concentration of stresses in creep conditions with nonsimple loading, 2:56337
Modeling of loads on hydraulic machinery blades, 2:56010
TURBINES
See also GAS TURBINES
HYDRAULIC TURBINES
STEAM TURBINES
TURBINES/QUALITY CONTROL
Use of holography in power engineering, 2:56314
TURBOGENERATORS
See also HYDRAULIC TURBINES
TURBOGENERATORS/ROTORS
Investigation of the structural strength of welded and forged turbogenerator rotors, 2:56330
TURBOMACHINERY
See also COMPRESSORS
PUMPS
TURBINES
TURBOMACHINERY/DESIGN
Ammonia turbomachinery design considerations for the direct cycle nuclear gas turbine waste heat power plant, 2:56440
Design of turbomachinery for the gas turbine (direct cycle) high temperature gas cooled reactor power plant, 2:56439
TURBOMACHINERY/MECHANICAL VIBRATIONS
Setting up vibration reliability testing systems for parts and units of power plant equipment, 2:56329
TURBOMACHINERY/PUMPS
Effect of rotor inlet conditions on the head characteristic of a condensate pump state, 2:56328
TURBOMACHINERY/ROTORS
Investigation of stability of asymmetrically supported rotors, 2:56269
TURBOMACHINERY/STEAM SEPARATORS
Investigation of a turboseparator with a freely rotating impeller, 2:56272
TURBOMACHINERY/SUBSONIC FLOW
Quasithreedimensional calculation of flow in turbine stages, 2:56327
TURBOMACHINERY/TURBINE BLADES
Analysis of the three-dimensional boundary layer in centrifugal impellers of turbomachines, 2:56270
TWO-PHASE FLOW/BOUNDARY CONDITIONS
Hydraulic resistance of supporting throttling washers, installed in horizontal pipes, to two-phase flow, 2:57302
TWO-PHASE FLOW/CALCULATION METHODS
One-dimensional motion of highly wet steam in nozzles, 2:57305
TWO-PHASE FLOW/FLOW MODELS
Motion of an evaporating drop in superheated steam flow, 2:57303
Unsteady expansions in homogeneous gas-liquid two-phase mixtures, 2:57299
TWO-PHASE FLOW/MATHEMATICAL MODELS
K-FIX: a computer program for transient, two-dimensional, two-fluid flow, 2:56785 (LA-NUREG-6623)
Synthoil hydrodynamics. Final report, 2:55600 (COO-0056-4)
Two-phase flow-rate measurement with sharp-edged orifices. theoretical investigation, 2:57298
TWO-PHASE FLOW/PRESSURE DROP
Frictional pressure drop in adiabatic high velocity two-phase flow, 2:57304
TYPE-II SUPERCONDUCTORS/FABRICATION
Space Processing Applications Rocket project, SPAR 1. Final report, 2:57093 (N-77-16082)
TYPE-III SUPERCONDUCTORS
See TYPE-II SUPERCONDUCTORS

U

UAR
See EGYPTIAN ARAB REPUBLIC
U-GAS PROCESS/COMPARATIVE EVALUATIONS
High- and low-Btu gas from Montana subbituminous coal, 2:55564 (CONF-770814-3)
U-GAS PROCESS/COST
High- and low-Btu gas from Montana subbituminous coal, 2:55564 (CONF-770814-3)
UKRAINIAN SSR/NATURAL GAS DEPOSITS
Direction of exploration and possibilities of hydrocarbon pool discoveries in the Volyno-Podolian area, 2:55747
Evaluation of oil and gas potential in Maykopian sedimentary rocks in crimeia, west pre-caucausus and offshore areas of Karkinit Bay and Azov Sea, 2:55754
UKRAINIAN SSR/PETROLEUM DEPOSITS
Direction of exploration and possibilities of hydrocarbon pool discoveries in the Volyno-Podolian area, 2:55747
Evaluation of oil and gas potential in Maykopian sedimentary rocks in crimeia, west pre-caucausus and offshore areas of Karkinit Bay and Azov Sea, 2:55754
ULTRAHIGH-SPEED PHOTOGRAPHY/PERFORMANCE
Subpicosecond proximity-focused streak camera for x-ray and visible light, 2:57643
Ultrafast x-ray diagnostics for laser fusion experiments, 2:57644
ULTRASONIC TESTING/ON-LINE MEASUREMENT SYSTEMS
Ultrasonic data acquisition, analysis, and display by minicomputer aided techniques, 2:57308 (SAND-77-0526C)
UNDERGROUND HEAT DISTRIBUTION SYSTEMS
See HEAT DISTRIBUTION SYSTEMS
UNDERGROUND MINING
See also LONGWALL MINING
ROOM AND PILLAR MINING
UNDERGROUND MINING/ACCIDENTS
Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume I. Development and application of cost model. Final report, 2:55732 (PB-264438)
UNDERGROUND MINING/CUTTING TOOLS
Coal planer (Patent; 13 claims), 2:55676
UNDERGROUND MINING/GROUND SUBSIDENCE
Subsidence of packing rocks under pressure, 2:55693
UNDERGROUND MINING/INFORMATION RETRIEVAL
Terminology and classification of qualitative characteristics of coal mines, 2:55697
UNDERGROUND MINING/INJURIES
Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume I. Development and application of cost model. Final report, 2:55732 (PB-264438)

Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume II. Program user manual. Final report, 2:55733 (PB-264439)
Accident cost indicator model to estimate costs to industry and society from work-related injuries and deaths in underground coal mining. Volume III. Supporting data. Final report, 2:55734 (PB-264440)
UNDERGROUND MINING/MINING EQUIPMENT
Fabricate and evaluate protective canopies for 3-foot coal seams. Final report, 1975-1976, 2:55673 (PB-265073)
Selection of the shape of cross-section of mine workings driven by combines, 2:55692
UNDERGROUND MINING/PLANNING
Study to determine research and development needs in western mining. Final report, 2:57281 (PB-264429)
UNDERGROUND MINING/REVIEWS
Mining engineering's annual review of coal and industrial minerals. I, 2:55684
UNDERGROUND MINING/SUBSURFACE STRUCTURES
Modern materials for underground support, 2:55689
UNDERGROUND NUCLEAR STATIONS
Assessment of underground siting of a nuclear power plant with PWR as an engineered safety feature, 2:56809
UNDERGROUND NUCLEAR STATIONS/FISSION PRODUCT RELEASE
Flow of radioactive gases through ground layers, 2:56750 (IKE-6-104)
UNION CARBIDE WASTE PROCESSING SYSTEM
See PUROX PYROLYSIS PROCESS
UNITED ARAB REPUBLIC
See EGYPTIAN ARAB REPUBLIC
UNITED KINGDOM/COAL MINING
Good prospects for coal in Great Britain, 2:55740
UNITED KINGDOM/DISTRICT HEATING
Economic benefits of district heating, 2:56910
UNITED KINGDOM/DUAL-PURPOSE POWER PLANTS
Economic benefits of district heating, 2:56910
Total energy merseyside power station extension, 2:56251
UNITED KINGDOM/ELECTRIC RAILWAYS
Energy saving public transport, 2:57066
UNITED KINGDOM/ENERGY POLICY
Energy policies of France Great Britain, and Germany compared, 2:56959
Good prospects for coal in Great Britain, 2:55740
UNITED KINGDOM/GEOTHERMAL RESOURCES
Geothermal resources in this country, 2:56175
UNITED KINGDOM/NATURAL GAS INDUSTRY
Modern mobile radio system, 2:55826
North Thames shuts down last gas-making station, 2:55991
Oil industry in Scotland, 2:56973
UNITED KINGDOM/PETROLEUM INDUSTRY
Changes in the petrol retailing movement (Self-Service Gasoline Stations), 2:55787
National outlets survey for the year-end 1976, 2:55788
Oil industry in Scotland, 2:56973
UNITED KINGDOM/POWER GENERATION
Generation game, 2:56231
UNITED STATES OF AMERICA
See USA
UNIVERSITY OF WISCONSIN TOKAMAK
See UWMAK DEVICES
URANIUM
See also ENRICHED URANIUM
URANIUM/CHEMICAL ANALYSIS
Coulometer operator's manual, 2:57194 (LA-6883-MS)
URANIUM/CHEMICAL REACTIONS
Uranium/water vapor reactions in gaseous atmospheres, 2:57242 (Y-2078)
URANIUM/EVAPORATION
Evaporator (Patent), 2:55866
URANIUM/GAMMA SPECTROSCOPY
Uranium, thorium, and potassium content of Precambrian rocks, Upper Peninsula of Michigan and northern Wisconsin. Supplement to GJBX-48(76). Uranium and thorium occurrences in Precambrian rocks, Upper Penninsula of Michigan and northern Wisconsin, with thoughts on other possible settings, 2:57196 (GJBX-43(77))
URANIUM/ION EXCHANGE
Recovery of uranium sulfate anions on a weak base anion exchange resin, 2:55862
URANIUM/MARKET
Survey of United States uranium marketing activity, 2:55893 (ERDA-77-46)
URANIUM/PROSPECTING
Hydrogeochemical and stream-sediment survey of the National Uranium Resource Evaluation (NURE) program: western United States. Quarterly progress report, January-March 1977, 2:55856 (UCID-16911-77-1)
URANIUM/SEPARATION PROCESSES
Process for separating ceramics of uranium and plutonium from zirconium by hydriding and mixtures thereof (Patent), 2:55884
URANIUM/SPECTROPHOTOMETRY
Evaluation of the LASL automated spectrophotometer for uranium determination at submilligram levels, 2:57203 (LA-6867)
URANIUM 235/CRITICALITY
Criticality safety in processing and handling fissile materials. Criticality data for uranium 235 dioxide light-water-mixtures, 2:55876
Reactivity enhancement in transportation and storage arrays due to fissile material density reductions, 2:57274
URANIUM 235/GASEOUS DIFFUSION PROCESS
Isotope separation processes, 2:57227
URANIUM 235/LASER ISOTOPE SEPARATION
Isotope separation processes, 2:57227
URANIUM 235/REACTIVITY
Reactivity enhancement in transportation and storage arrays due to fissile material density reductions, 2:57274
URANIUM 235 TARGET/NEUTRON REACTIONS
X rays from fragments in fission of ^{235}U by 3.5-MeV neutrons, 2:57609
URANIUM 235 TARGET/PHOTOFISSION
Method of obtaining photonuclear cross sections in the near-threshold region, 2:57611
URANIUM 238/FISSION YIELD
Actinide fission rate measurements in Zebra, 2:56474 (AEEW-R-1090)
URANIUM 238 TARGET/CARBON 12 REACTIONS
Large collision residues and nuclear fission in the interaction of 25.2-GeV ^{12}C with uranium, 2:57604
URANIUM 238 TARGET/NEUTRON REACTIONS
Differential cross section of ^{238}U at 144 keV, 2:57602
Measurement of the ^{238}U subthreshold fission cross section for incident neutron energies between 0.6 and 100 keV, 2:57606
URANIUM CARBIDES/SURFACE COATING
Fuel particles with coatings without property gradients (Patent), 2:55869
URANIUM CARBIDES/SWELLING
Efect of porosity on the steady-state swelling of UC, 2:56707
URANIUM CARBIDES/WETTABILITY
Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R-1746)
URANIUM DEPOSITS
See also RANGER DEPOSIT
URANIUM DEPOSITS/EVALUATION
Recognition and evaluation of uraniferous areas. Panel proceedings series, 2:55855 (STI/PUB-450)
URANIUM DEPOSITS/EXPLORATION
Middle--upper Devonian clastic wedge of the Franklinian geosyncline, 2:55750
Uranium exploration methods development, 2:55858
Uranium exploration '75, 2:55853
URANIUM DEPOSITS/GAMMA LOGGING
Spatial dependence of delayed-neutron signals from uranium exploration probes, 2:55857
URANIUM DEPOSITS/GEOCHEMICAL SURVEYS
Hydrogeochemical and stream sediment reconnaissance: eastern United States. Savannah River Laboratory quarterly report, April-June 1977. National Uranium Resource Evaluation program, 2:55854 (DPST-77-138-2)
URANIUM DEPOSITS/GEOPHYSICAL SURVEYS
Uranium exploration methods development, 2:55858
URANIUM DEPOSITS/MEETINGS
Recognition and evaluation of uraniferous areas. Panel proceedings series, 2:55855 (STI/PUB-450)
URANIUM DIOXIDE/BUBBLES
Equation-of-state and nonequilibrium bubble behavior during fast transients, 2:56799
URANIUM DIOXIDE/CHEMICAL PREPARATION
Production of uranium dioxide (Patent 3; stage fluidized bed reaction of UF_6 with H_2 and steam), 2:55864
URANIUM DIOXIDE/CRITICALITY
Criticality safety in processing and handling fissile materials. Criticality data for uranium 235 dioxide light-water-mixtures, 2:55876
URANIUM DIOXIDE/DIFFUSION
Aerosol measurements and modeling for fast reactor safety. Task 7. Quarterly progress report, October 1-December 31, 1976 (LMFBR; time dependent aerosol suspension behavior), 2:56768 (BMI-NUREG-1969)
URANIUM DIOXIDE/EVAPORATION
Evaporation kinetics of oxide fuels and their effect on the actinide redistribution in reactor fuel pins and on fuel vapor pressure under accident conditions, 2:56878 (EURFNR-1370)
URANIUM DIOXIDE/FABRICATION
Fuels characterization in LMFBR, 2:56544

Preparation of mixed oxide nuclear fuel (Patent), 2:55874
URANIUM DIOXIDE/FISSION PRODUCT RELEASE
Effect of solid fission products and dislocations on swelling and fission gas release in oxides during a fast overpower transient, 2:56800
URANIUM DIOXIDE/PHYSICAL RADIATION EFFECTS
Postirradiation examinations of the BG-9 element, 2:56475 (ANL-8067)
URANIUM DIOXIDE/SINTERING
Ammonia as a sintering aid for UO_2, 2:55875
URANIUM DIOXIDE/VAPOR PRESSURE
Evaporation studies of liquid oxide fuel at very high temperatures using laser beam heating, 2:56774 (EURFNR-1400)
URANIUM HEXAFLUORIDE/CHEMICAL ANALYSIS
Analytical capability of the uranium hexafluoride mass spectrometer, 2:57202 (GAT-T-2657)
URANIUM HEXAFLUORIDE/CRITICALITY
Criticality safety survey computations of uranium hexafluoride freezer/sublimer tube lattices, 2:57272 (K/DD-1000)
URANIUM HEXAFLUORIDE/PACKAGING
Safety analysis report on the "Paducah Tiger" protective overpack for 10-ton cylinders of uranium hexafluoride. Supplement 1, 2:57276 (KY-665(Suppl.1))
URANIUM ISOTOPES/ISOTOPE RATIO
Analytical capability of the uranium hexafluoride mass spectrometer, 2:57202 (GAT-T-2657)
URANIUM ISOTOPES/LASER ISOTOPE SEPARATION
Evaporator (Patent), 2:55866
URANIUM MINES/ECONOMICS
Utah's uranium mines operated by new company as merger requirement, 2:55860
URANIUM MINES/ENVIRONMENTAL EFFECTS
Social and environmental assessment of coal and uranium in the Western United States, 2:55939
URANIUM MINES/ENVIRONMENTAL IMPACTS
Ranger uranium environmental enquiry. Final submission by the Australian Atomic Energy Commission, 2:55934 (INIS-mf-3272)
URANIUM MINES/OPERATION
Utah's uranium mines operated by new company as merger requirement, 2:55860
URANIUM MINES/VENTILATION
Portable instrument measures four ventilation parameters, 2:55861
URANIUM NITRIDES/EQUATIONS OF STATE
Self-consistent normal fluid equation-of-state for (U,Pu)N, 2:56849
URANIUM ORES/AERIAL PROSPECTING
Gamma-ray measurement and data reduction considerations for airborne radiometric surveys, 2:55859
URANIUM ORES/MILLING
Measurements of surface radon fluxes from uranium mill tailings, 2:55940
URANIUM ORES/ORE PROCESSING
Carbonate leach uranium ore processing with sodium polyacrylate flocculant (Patent), 2:55863
URANIUM OXIDES
See also URANIUM DIOXIDE
URANIUM OXIDES/SURFACE COATING
Fuel particles with coatings without property gradients (Patent), 2:55869
URANIUM OXIDES/THERMODYNAMIC PROPERTIES
Thermodynamic functions and vapor pressures of uranium and plutonium oxides at high temperatures (From spectroscopy (third-law method)), 2:55867 (CONF-770537-2)
URANIUM OXIDES/WETTABILITY
Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R-1746)
URANYL NITRATES/CHEMICAL PREPARATION
Purex process operation and performance, 1970 Thoria Campaign, 2:55879 (ARH-2127)
URBAN AREAS
Land use-energy simulation model: a computer-based model for exploring land use and energy relationships, 2:56915 (BNL-50634)
URBAN AREAS/DISTRICT HEATING
Principles of design of schemes of district heating systems in cities, their automation, and installation of remote control facilities, 2:56913
URBAN AREAS/TRANSPORTATION SYSTEMS
Small bus program: vehicle operation efficiency report. Part I. experimental bus program (15-20 passenger buses). Part II. Van conversions for dial-a-ride service (12 passenger buses), 2:56941 (PB-265131)
URETHANE/CROSS-LINKING
Polyurethane elastomer system, 2:57170 (GEPP-305)
URETHANE/SHEAR PROPERTIES
Polyurethane elastomer system, 2:57170 (GEPP-305)
US ERDA/DEMONSTRATION PLANTS
ERDA demonstration plant program for high-Btu gas, 2:55594
US ERDA/DEMONSTRATION PROGRAMS
ERDA demonstration plant program for high-Btu gas, 2:55594
US ERDA/MEETINGS
Proceedings of the public meeting to review the status of the inexhaustible energy resources study, 2:56985 (CONF-770560-)
US ERDA/RESEARCH PROGRAMS
Overview of the federal solar energy program and current technology status, 2:56014
US FEA/NUCLEAR ENERGY
Emerging role of FEA in nuclear energy expansion, 2:56939
US FEA/REGULATIONS
Coal conversion program: Energy supply and Environmental Coordination Act (as amended). Section 2. Draft environmental statement, 2:56961 (PB-265815)
USA
See also ALABAMA
ALASKA
CALIFORNIA
COLORADO
CONNECTICUT
FLORIDA
HAWAII
IOWA
KANSAS
MARYLAND
MINNESOTA
MONTANA
NEBRASKA
NEW MEXICO
NEW YORK
NORTH DAKOTA
OKLAHOMA
OREGON
SOUTH CAROLINA
UTAH
VIRGINIA
WASHINGTON
WISCONSIN
USA/AIR POLLUTION
National trends in trace metals in ambient air, 1965-1974, 2:57354 (EPA-450/1-77-003)
USA/COAL GASIFICATION
Report on coal. Status report of the Ad Hoc Committee on Energy Resources and Technology of the Atomic Industrial Forum, March 1975 (26 refs), 2:55658 (NP-22116)
USA/COAL LIQUEFACTION
Report on coal. Status report of the Ad Hoc Committee on Energy Resources and Technology of the Atomic Industrial Forum, March 1975 (26 refs), 2:55658 (NP-22116)
USA/COAL LIQUEFACTION PLANTS
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-1. Environmental considerations affecting the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55605 (FE-1752-16)
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-3. Availability of water for the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55606 (FE-1752-18)
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-5. Manpower requirements. Final report, January 1975-December 1976, 2:55607 (FE-1752-20)
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. The role of synthetic liquids from coal in meeting future energy demand. Final report, January 1975-December 1976, 2:55603 (FE-1752-14)
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Ownership issues: alternative structures for creating a commercial coal liquefaction industry. Final report, January 1975-December 1976, 2:55604 (FE-1752-15)
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Economic issues affecting the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55608 (FE-1752-21)
USA/COAL MINING
Report on coal. Status report of the Ad Hoc Committee on Energy Resources and Technology of the Atomic Industrial Forum, March 1975 (26 refs), 2:55658 (NP-22116)
USA/COAL RESERVES
Report on coal. Status report of the Ad Hoc Committee on Energy Resources and Technology of the Atomic Industrial Forum, March 1975 (26 refs), 2:55658 (NP-22116)
USA/ELECTRIC POWER
Report on the Western Energy Expansion Study, 2:56986 (NP-22295)
USA/ENERGY CONSUMPTION
Energy flow patterns for 1975 (For 50 states, regions and total U.S.), 2:56982 (LA-6770)

USA/ENERGY SOURCES
Free' and renewable energy sources, 2:56170
USA/FORECASTING
Free' and renewable energy sources, 2:56170
USA/FOREIGN POLICY
Petropolitics and the Atlantic Alliance (Short- and long-term effects of petroleum crisis), 2:56969 (AD-A-037807)
USA/GEOCHEMICAL SURVEYS
Hydrogeochemical and stream sediment reconnaissance: eastern United States. Savannah River Laboratory quarterly report, April-June 1977. National Uranium Resource Evaluation program, 2:55854 (DPST-77-138-2)
Hydrogeochemical and stream-sediment survey of the National Uranium Resource Evaluation (NURE) program: western United States. Quarterly progress report, January-March 1977, 2:55856 (UCID-16911-77-1)
USA/LAND USE
Report on the Western Energy Expansion Study, 2:56986 (NP-22295)
USA/NUCLEAR POWER PLANTS
Economic and environmental implications of a U.S. nuclear moratorium, 1985-2010, 2:56741 (ORAU/IEA-76-4)
Guidelines for estimating present and forecasting future population distributions surrounding power reactor sites. (Draft of a standard), 2:56743 (EPRI-EA-427-SR)
USA/SEISMIC SURVEYS
Earthquake activity in the Southeastern United States, 2:57471
Evaluation of earthquake hazard in the central Mississippi Valley, 2:56744
Geologic perspectives of earthquake hazards in East-Central United States, 2:57467
Problems of seismic risk analysis in the Northeast United States, 2:57468
Relationship of seismicity to geology in the Northeastern United States, 2:57469
USA/SPENT FUEL STORAGE
Spent fuel storage in the USA, 2:55890
USA/SYNTHETIC FUELS INDUSTRY
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-5. Manpower requirements. Final report, January 1975-December 1976, 2:55607 (FE-1752-20)
USA/URANIUM RESERVES
Outlook for uranium and enrichment supply in the United States, 2:55852
USA/WATER RESOURCES
Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-3. Availability of water for the development of a coal liquefaction industry. Final report, January 1975-December 1976, 2:55606 (FE-1752-18)
Report on the Western Energy Expansion Study, 2:56986 (NP-22295)
USA/WIND POWER
Wind energy mission analysis. Executive summary, 2:56219 (TID-27698)
USA/WIND POWER PLANTS
Wind energy mission analysis. Executive summary, 2:56219 (TID-27698)
USSR
See also UKRAINIAN SSR
USSR/AIR POLLUTION
Ways to reduce atmospheric pollution in cities by fuel combustion products, 2:56348
USSR/BREEDER REACTORS
Nuclear power industry in the tenth five-year plan period, 2:56390
USSR/BWR TYPE REACTORS
Nuclear power industry in the tenth five-year plan period, 2:56390
USSR/CARBONATE ROCKS
Paleozoic carbonate formations in the south-east of Russian Platform and their oil and gas potential, 2:55752
USSR/CHEMICAL INDUSTRY
Complex utilization of raw materials and materials by chemical industry in conditions of automated norm-setting system of the azerbaijan republic, 2:57033
USSR/COAL DEPOSITS
Power industry of Siberia in the tenth five-year plan period, 2:55665
USSR/COAL INDUSTRY
Principal lines of development of science and technology in the tenth five-year plan period, 2:55688
USSR/DISTRICT HEATING
Principles of nuclear district heating, 2:56611
Scientific and technical problems of district heating in the tenth five-year plan period, 2:57006
USSR/FOSSIL-FUEL POWER PLANTS
Power industry of Siberia in the tenth five-year plan period, 2:55665
USSR/GAS CONDENSATE FIELDS
Directions and tasks of oil exploration in the southern part of Timan-Pechora province for 1976-1980, 2:55807
USSR/GEOLOGIC STRUCTURES
Oil and gas geological zoning of the Siberian Platform, 2:55741
USSR/GEOLOGICAL SURVEYS
Oil and gas geological zoning of the Siberian Platform, 2:55741
USSR/GRAPHITE MODERATED REACTORS
Nuclear power industry in the tenth five-year plan period, 2:56390
USSR/HEAT FLOW
Development of geothermal models, 2:56178
USSR/HYDROELECTRIC POWER PLANTS
Power industry of Siberia in the tenth five-year plan period, 2:55665
USSR/NATURAL GAS DEPOSITS
Data base for analyzing results of oil and gas exploration, 2:55748
Directions and tasks of oil exploration in the southern part of Timan-Pechora province for 1976-1980, 2:55807
Formation of oil and gas pools and technique for their exploration in southern regions of Siberian platform, 2:55753
Oil and gas geological zoning of the Siberian Platform, 2:55741
Power industry of Siberia in the tenth five-year plan period, 2:55665
Predicting oil and gas potential from tectonic conditions of distribution of oil and gas fields in west Pre-caucasus, 2:55743
USSR/NUCLEAR POWER
Nuclear power industry in the tenth five-year plan period, 2:56390
USSR/PETROLEUM DEPOSITS
Data base for analyzing results of oil and gas exploration, 2:55748
Formation of oil and gas pools and technique for their exploration in southern regions of Siberian platform, 2:55753
Oil and gas geological zoning of the Siberian Platform, 2:55741
Power industry of Siberia in the tenth five-year plan period, 2:55665
Predicting oil and gas potential from tectonic conditions of distribution of oil and gas fields in west Pre-caucasus, 2:55743
USSR/POWER GENERATION
Power industry in the first year of the tenth five-year plan period and the tasks for 1977, 2:56979
USSR/PWR TYPE REACTORS
Nuclear power industry in the tenth five-year plan period, 2:56390
USSR/STEAM GENERATION
Power industry in the first year of the tenth five-year plan period and the tasks for 1977, 2:56979
USSR/TECTONICS
Predicting oil and gas potential from tectonic conditions of distribution of oil and gas fields in west Pre-caucasus, 2:55743
USSR/THERMONUCLEAR REACTORS
Nuclear power industry in the tenth five-year plan period, 2:56390
USSR/TOKAMAK DEVICES
Nuclear power industry in the tenth five-year plan period, 2:56390
UTAH/ELECTRIC POWER
Impacts of the western drought on regional electricity generation. Interim report, 2:56975 (PB-265 641)
UTAH/URANIUM MINES
Utah's uranium mines operated by new company as merger requirement, 2:55860
UWMAK DEVICES
(University of Wisconsin Tokamak.)
UWMAK DEVICES/SUPERCONDUCTING MAGNETS
Conceptual demountable TF magnet design for UWMAK-II fusion reactor, 2:57735
Engineering considerations of the toroidal magnet and dewar for UWMAK. II. A Wisconsin Tokamak fusion reactor design, 2:57718

V

VALVES/DESIGN
Coal gasification valves. Phase I. Component development test procedure, 2:55575 (FE-2355-12(Rev.A))
Door valve (Patent; LMFBR), 2:56572
Evaluation of valves for Cresap testing, 2:55602 (FE-1517-24)
Leakage control device in a main steam isolating valve (Patent), 2:56702
Versatile multiple outlet semi-ball and socket valve, 2:57250 (CONF-770634-1)
VALVES/HEAT TRANSFER
Coal gasification valves. Phase I. Thermal analysis report, 2:55579 (FE-2355-16)
VALVES/MATERIALS
Status of Wilsonville Solvent Refined Coal pilot plant. Interim report, 2:55601 (EPRI-1234)

VALVES/PERFORMANCE TESTING
Coal gasification valves. Phase I. Stress analysis report, 2:55576 (FE-2355-13)
Coal gasification valves. Phase I. Type III valve prototype test plan, 2:55577 (FE-2355-14)
Steam-flow and seismic tests of nuclear ball valves verify design and fabrication, 2:56660
Stuffing box test procedure, 2:55581 (FE-2356-20)
VALVES/RELIABILITY
Advances in small zero-leak valves point to better nuclear power-plant reliability, 2:56657
VALVES/SERVICE LIFE
Status of Wilsonville Solvent Refined Coal pilot plant. Interim report, 2:55601 (EPRI-1234)
VALVES/SPECIFICATIONS
Coal gasification valves. Phase I. Design analysis report, 2:55578 (FE-2355-15)
VALVES/STRESSES
Coal gasification valves. Phase I. Stress analysis report, 2:55576 (FE-2355-13)
VALVES/THERMAL ANALYSIS
Coal gasification valves. Phase I. Thermal analysis report, 8-inch, Types I, II, and IV valves, 2:55580 (FE-2355-19)
VAN ALLEN BELTS
See RADIATION BELTS
VANADIUM/CORROSION
Corrosion of iron-base alloys by lithium, 2:57134 (CONF-760503-P2)
VANADIUM/CRITICAL CURRENT
Pinning in niobium and vanadium single crystals containing hydrogen, 2:57162
VANADIUM/ELECTRIC CONDUCTIVITY
Pinning in niobium and vanadium single crystals containing hydrogen, 2:57162
VANADIUM/MAGNETIC FLUX
Pinning in niobium and vanadium single crystals containing hydrogen, 2:57162
VANADIUM/PHYSICAL RADIATION EFFECTS
Primary recoil energy spectra considerations in ion-bombardment experiments, 2:57149
Void formation from 200 to 700°C in heavy-ion irradiated vanadium, 2:57150
Void swelling in V-ion-irradiated V-O alloys, 2:57151
VANADIUM ALLOYS
See also VANADIUM BASE ALLOYS
VANADIUM ALLOYS/STRESS CORROSION
Stress-corrosion studies on materials used for surgical implants (T318), 2:57138
VANADIUM BASE ALLOYS/PHYSICAL RADIATION EFFECTS
Void swelling in V-ion-irradiated V-O alloys, 2:57151
VANADIUM BASE ALLOYS/QUENCHING
Effects of rapid quenching of superconductors, 2:57096
VANADIUM BASE ALLOYS/TRANSITION TEMPERATURE
Effects of rapid quenching of superconductors, 2:57096
VANADIUM CARBIDES/QUENCHING
Effects of rapid quenching of superconductors, 2:57096
VANADIUM CARBIDES/TRANSITION TEMPERATURE
Effects of rapid quenching of superconductors, 2:57096
VANADIUM CARBIDES/WETTABILITY
Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R-1746)
VANADIUM HYDRIDES/CRITICAL CURRENT
Pinning in niobium and vanadium single crystals containing hydrogen, 2:57162
VANADIUM HYDRIDES/ELECTRIC CONDUCTIVITY
Pinning in niobium and vanadium single crystals containing hydrogen, 2:57162
VANADIUM HYDRIDES/MAGNETIC FLUX
Pinning in niobium and vanadium single crystals containing hydrogen, 2:57162
VANADIUM OXIDES/ABSORPTION SPECTRA
Optical absorption of vanadium pentoxide in the energy range 1.0-5.5 eV, 2:57159
Optical absorption of VO_2 and V_2O_3 films and ability to predict semiconductor-semimetal phase transitions in transition metal compounds, 2:57160
VANADIUM OXIDES/CORROSIVE EFFECTS
Some questions of high-temperature vanadic corrosion and principal lines of development of heat-resistant materials, 2:57137
VANADIUM OXIDES/ELECTRO-OPTICAL EFFECTS
Electrochromism in V_2O_5 films, 2:57161
VANPOOLING/FEASIBILITY STUDIES
Organizing and operating a vanpool program: feasibility of vanpooling in Virginia. Final report, 2:56940 (PB-264635)
VAPOR PRESSURE/ISOTOPE EFFECTS
Condensed phase isotope effects, especially vapor pressure isotope effects: aqueous solutions, 2:57234
VARIABLE STARS/CHEMICAL COMPOSITION
CH lines in the spectrum of the magnetic variable 73 Draconis, 2:57481
VARIABLE STARS/SPECTRA
CH lines in the spectrum of the magnetic variable 73 Draconis, 2:57481
VARIATIONAL METHODS/COLLISIONS
Variational principles, subsidiary extremum principles, and variational bounds (Review), 2:57548
VECTOR MESONS
(Mesons with spin-one.)
See also OMEGA-784 RESONANCES
PSI RESONANCES
RHO-765 RESONANCES
VECTOR MESONS/DECAY
Intermultiplet mixing of the vector mesons in a nonperturbative approach to broken SU(4), 2:57586
VECTOR MESONS/MASS FORMULAE
Intermultiplet mixing of the vector mesons in a nonperturbative approach to broken SU(4), 2:57586
VEGETABLES
(Edible parts of plants only.)
VEGETABLES/CONTAMINATION
Concentrations of radionuclides and selected stable elements in fruits and vegetables, 2:57381 (CONF-770676-1)
VEGETATION
See PLANTS
VEHICLES
See also AUTOMOBILES
BUSES
ELECTRIC-POWERED VEHICLES
VEHICLES/PERFORMANCE TESTING
Endurance testing of tracked and wheeled vehicles. Final report, 2:57072 (AD-A-037827)
VENUS PLANET/IONOSPHERE
Electron currents measured in the optical shadow of Venus by the "Venera-9" and "Venera-10" satellites; the basic source of ionization in the nightside ionosphere of Venus, 2:57489
VERSENE
See EDTA
VERTICAL AXIS TURBINES
Higher efficiency wind motor with receptors of diminished drag characteristics (Patent), 2:56225
VESSELS
See CONTAINERS
VESSELS (PRESSURE)
See PRESSURE VESSELS
VIRGINIA/ENERGY SOURCES
Energy and Virginia's future: a report of the Virginia Energy Resource Advisory Commission, 2:56949 (NP-21880)
VIRGINIA/ENERGY SUPPLIES
Energy and Virginia's future: a report of the Virginia Energy Resource Advisory Commission, 2:56949 (NP-21880)
VIRGINIA/VANPOOLING
Organizing and operating a vanpool program: feasibility of vanpooling in Virginia. Final report, 2:56940 (PB-264635)
VIRUSES
See also BACTERIOPHAGES
VIRUSES/BIOCHEMISTRY
DNA replication of the parvovirus Kilham rat virus. I. Characterization of intracellular forms of viral DNA extracted by guanidine hydrochloride, 2:57410 (CONF-770555-2)
Double-helical regions in Kilham rat virus DNA, 2:57409 (CONF-770555-1)
VIRUSES/INFECTIVITY
DNA replication of the parvovirus Kilham rat virus. I. Characterization of intracellular forms of viral DNA extracted by guanidine hydrochloride, 2:57410 (CONF-770555-2)
VISCOUS FLOW/FLOW MODELS
Analysis of the three-dimensional boundary layer in centrifugal impellers of turbomachines, 2:56270
VITALLIUM/PITTING CORROSION
Stress-corrosion studies on materials used for surgical implants, 2:57138
VITALLIUM/STRESS CORROSION
Stress-corrosion studies on materials used for surgical implants, 2:57138
VOLCANOES/SEISMIC SURVEYS
Seismometrical observation in Hakone volcano, 1973, 2:56188
VOLTAIC CELLS
See ELECTRIC BATTERIES
VOLTAMETRY
Coulometer operator's manual, 2:57194 (LA-6883-MS)
VORTEX FLOW/FLOW RATE
Measuring fluid flow by vortex shedding, 2:55825
VORTEX FLOW/MEASURING METHODS
Measuring fluid flow by vortex shedding, 2:55825

W

W BOSON
See INTERMEDIATE BOSONS
WALLS/LATENT HEAT STORAGE
Thermocrete heat storage materials: applications and performance specifications, 2:56167
WASHINGTON/ELECTRIC POWER
Impacts of the western drought on regional electricity generation. Interim report, 2:56975 (PB-265 641)
WASTE DISPOSAL
See also MARINE DISPOSAL
RADIOACTIVE WASTE DISPOSAL
SANITARY LANDFILLS
Reference materials system: a source for renewable materials assessment, 2:56927 (PB-264494)
WASTE DISPOSAL/ENVIRONMENTAL EFFECTS
The report to Congress: waste disposal practices and their effects on ground water. executive summary. Final report, 2:56957 (PB-265364)
WASTE DISPOSAL/FEASIBILITY STUDIES
Solid waste disposal feasibility study for Richmond County, Georgia Board of Commissioners, 2:57316 (PB-264471)
WASTE HEAT/HEAT RECOVERY
Comparison between regenerative and recuperative heat recovery systems in ventilating plants, 2:57045
Heat recuperator: improved heat transfer efficiency, 2:57044
Methods for conveying and utilization of waste heat from power plants, 2:56341
Thermal operation of double-bath steel-smelting furnaces, 2:57042
Waste heat management guidebook. Final report, 2:57043 (PB-264959)
WASTE HEAT/SENSIBLE HEAT STORAGE
High-temperature energy storage in native rocks, 2:56159
WASTE HEAT UTILIZATION
European waste-to-energy systems. An overview, 2:57022 (CONS/2103-6)
WASTE MANAGEMENT
See also RADIOACTIVE WASTE MANAGEMENT
WASTE DISPOSAL
WASTE PROCESSING
WASTE TRANSPORTATION
Recycling waste (Book), 2:56925
WASTE OILS/RECYCLING
Method of rerefining oil with recovery of useful organic additives (Patent), 2:55790
WASTE PROCESSING
See also MATERIALS RECOVERY
PUROX PYROLYSIS PROCESS
RADIOACTIVE WASTE PROCESSING
Recycling waste (Book), 2:56925
WASTE PROCESSING PLANTS/CAPACITY
European waste-to-energy systems: case study of Geneva-Cheneviers (Switzerland), 2:56987 (CONS/2103-2)
WASTE PROCESSING PLANTS/CO-GENERATION
European waste-to-energy systems. Case study of Munich: Munich North IA and IB, Munich North II, Munich South IV and V, 2:56981 (CONS/2103-4)
WASTE PROCESSING PLANTS/DESIGN
European waste-to-energy systems: case study of the thermal complex of Toulouse-Le Mirail (France), 2:55999 (CONS/2103-1)
WASTE PROCESSING PLANTS/DISTRICT HEATING
European waste-to-energy systems: case study of Koersor, Denmark, 2:56980 (CONS/2103-3)
European waste-to-energy systems. Case study of Munich: Munich North IA and IB, Munich North II, Munich South IV and V, 2:56981 (CONS/2103-4)
WASTE PROCESSING PLANTS/OPERATION
European waste-to-energy systems: case study of the thermal complex of Toulouse-Le Mirail (France), 2:55999 (CONS/2103-1)
WASTE PROCESSING PLANTS/POWER GENERATION
European waste-to-energy systems: case study of Geneva-Cheneviers (Switzerland), 2:56987 (CONS/2103-2)
WASTE PROCESSING PLANTS/SOLID WASTES
Refuse incineration and heating in middle-sized cities, 2:56001
WASTE PROCESSING PLANTS/STEAM GENERATION
Refuse incineration and heating in middle-sized cities, 2:56001
WASTE TRANSPORTATION/RISK ASSESSMENT
Preliminary risk analysis of the transportation of nuclear waste, 2:55948
Risk analysis of the road transport of radioactive waste in the Netherlands, 2:55950
Transportation of vitrified high-level radioactive waste by rail: fault tree analysis and accidental release, 2:55949
WASTE WATER/FLOCCULATION
Feasibility of using electrochemical coagulation to purify mine water (9 refs), 2:55653
WASTE WATER/WASTE PROCESSING
Process design manual for phosphorus removal, 2:57207 (EPA-625/1-76-001a)
WASTE WATER/WATER TREATMENT
Don't waste waterweeds (Use of water hyacinths as fertilizer, biogas generator, and animal feed), 2:55994
State of the art: wastewater management in the beverage industry, 2:57047 (EPA-600/2-77-048)
WASTES
See also GASEOUS WASTES
INDUSTRIAL WASTES
MUNICIPAL WASTES
ORGANIC WASTES
RADIOACTIVE WASTES
SEWAGE
SOLID WASTES
WASTE HEAT
WASTES/AGGLOMERATION
Selective agglomeration in the treatment of fine coal refuse, 2:55652
WASTES/MIXING
Mixing process of pollutants in coastal waters, 2:57392 (NIRS-M-10)
WASTES/RECYCLING
Recycling waste (Book), 2:56925
WATER
See also DRINKING WATER
FEEDWATER
GROUND WATER
HEAVY WATER
SEAWATER
SURFACE WATERS
WATER/DIELECTRIC PROPERTIES
Estimate of the intermolecular polarization contribution to the static dielectric constant of water, 2:57216
Isotopic effects on the electronic properties of H_2O and D_2O in the vacuum uv, 2:57221
WATER/ENERGY LEVELS
Theoretical studies of the atmospheric triatomic molecules H_2O, N_2O, NO_2, CO_2, O_3, and their ions, 2:57501 (ANL-77-3)
WATER/ENTHALPY
Procedure for estimating the temperature of a hot-water component in a mixed water by using a plot of dissolved silica versus enthalpy, 2:56209
WATER/FLUID FLOW
Calculated and observed nonisothermal multiphase in flow in vertical columns (Mathematical model for movement of air, water vapor, and liquid water in dry desert soil), 2:57375 (ARH-SA-278)
WATER/OPTICAL PROPERTIES
Isotopic effects on the electronic properties of H_2O and D_2O in the vacuum uv, 2:57221
WATER COOLED REACTORS
See also BWR TYPE REACTORS
PWR TYPE REACTORS
SGHWR REACTOR
WATER COOLED REACTORS/BLOWDOWN
Tracking nonstationary velocity in two-phase flow by an adaptive cross-correlation algorithm, 2:56814
WATER COOLED REACTORS/ECCS
Bubble growth by expansion and dissolution in a variable pressure field, 2:56813
WATER COOLED REACTORS/FUEL CYCLE
Alternative fuel cycle technology progress report for April 1-June 30, 1977 (LWR off-gas treatment; ^{129}I adsorbent and storage development; waste management), 2:55900 (ICP-1122)
Feasibility of plutonium separation-free nuclear power economy with LWHRs, 2:56550
Light water reactor fuel reprocessing and recycling, 2:55933 (ERDA-77-75)
WATER COOLED REACTORS/FUEL ELEMENTS
Effect of variable thermal conductivity in thermal-hydraulic calculations, 2:56875
WATER COOLED REACTORS/FUEL-COOLANT INTERACTIONS
Molten fuel-coolant interaction during hypothetical accidents in light water reactors, 2:56876
WATER COOLED REACTORS/MELTDOWN
Experiences with vapor explosions caused by entrapment of water with melts, 2:56868
Molten fuel-coolant interaction during hypothetical accidents in light water reactors, 2:56876
WATER COOLED REACTORS/REACTOR ACCIDENTS
K-FIX: a computer program for transient, two-dimensional, two-fluid flow, 2:56785 (LA-NUREG-6623)

WATER COOLED REACTORS/SABOTAGE
Safety and security of nuclear power reactors to acts of sabotage, 2:56396
WATER COOLED REACTORS/SECURITY
Safety and security of nuclear power reactors to acts of sabotage, 2:56396
WATER COOLED REACTORS/SHIELDING
Where are we and where are we going in reactor shielding, 2:56651 (CONF-770401-5)
WATER COOLED REACTORS/STEAM GENERATORS
Steam generator tube failures: world experience in water-cooled nuclear reactors in 1975, 2:56397
WATER COOLED REACTORS/TEMPERATURE DEPENDENCE
Effect of variable thermal conductivity in thermal-hydraulic calculations, 2:56875
WATER COOLED REACTORS/TRANSIENTS
Effect of variable thermal conductivity in thermal-hydraulic calculations, 2:56875
WATER GAS/METHANATION
Process for the methanation of gases containing high concentration of carbon monoxide (Patent; methanation of water gas from coal gasification), 2:55987
WATER HEATERS/ENERGY CONSERVATION
Energy conservation in the production of hot water, 2:57016
WATER HEATERS/ENERGY EFFICIENCY
Energy and cost analysis of residential water heaters, 2:57014 (ORNL/CON-10)
WATER POLLUTION/BIOLOGICAL EFFECTS
Chemical composition and effects of water extracts of petroleum on eggs of the sand dollar Melitta quinquiesperforata, 2:57448
WATER POLLUTION/BIOLOGICAL INDICATORS
Fishing for toxicity: biological automonitor for continuous water quality control, 2:57396
WATER POLLUTION/RESEARCH PROGRAMS
Fiscal year 1976/health and environmental effects research program abstracts, 2:57360 (PB-265381)
WATER POLLUTION CONTROL/DECISION MAKING
Connecticut river water resource decision-making. Completion report, 2:57394 (PB-265390)
WATER RESERVOIRS
See also COOLING PONDS
WATER RESERVOIRS/THERMAL POLLUTION
The age and growth of the largemouth bass 'Micropterus salmoides' (lacepede), in a thermally loaded reservoir, 2:57441 (PB-264914)
WATER RESOURCES/AVAILABILITY
Energy and natural resources, 2:56930
WATER RESOURCES/EVALUATION
Water resources appraisal for hydroelectric licensing Kern River Basin, California, 2:56002 (PB-264750)
WATER RESOURCES/WATER POLLUTION ABATEMENT
Connecticut river water resource decision-making. Completion report, 2:57394 (PB-265390)
WATER VAPOR/CHEMICAL REACTIONS
Uranium/water vapor reactions in gaseous atmospheres, 2:57242 (Y-2078)
WATER VAPOR/FLUID FLOW
Calculated and observed nonisothermal multiphase in flow in vertical columns (Mathematical model for movement of air, water vapor, and liquid water in dry desert soil), 2:57375 (ARH-SA-278)
WAVE ENERGY CONVERTERS/DESIGN
Energy recovery from sea waves with the aid of oscillating floating bodies, 2:56217
WAVE POWER
Forecast computation of maximum wave at Venice lagoon inlet entrances, 2:56218
WEAK BOSON
See INTERMEDIATE BOSONS
WEAK INTERACTIONS/COLOR MODEL
Weak interaction of colored hadrons, 2:57576
WEAK NEUTRAL CURRENTS/P INVARIANCE
Parity violation in atoms due to neutral weak currents, 2:57556
WELDED JOINTS/FATIGUE
Fatigue behavior of nozzles of light water reactor pressure vessel model, 2:56387
Fatigue strength of electron beam welded stainless steel pipes, 2:57259
WELDED JOINTS/FRACTURE PROPERTIES
Assessment of toughness and cracking in the heat-affected zone of light water reactor components, 2:56386
WELDED JOINTS/MECHANICAL TESTS
Investigation of the structural strength of welded and forged turbogenerator rotors, 2:56330
WELDED JOINTS/QUALITY CONTROL
Pressure containing welds in nuclear power systems : meeting the special requirements, 2:56685
Raising the reliability of boiler units by improving the quality of welding of the heating surfaces, 2:56273
WELDED JOINTS/RESIDUAL STRESSES
Transient and residual stresses from multipass weld in very thick plates and their reduction from stress relief annealing, 2:57262
WELDED JOINTS/STRESS ANALYSIS
Transient and residual stresses from multipass weld in very thick plates and their reduction from stress relief annealing, 2:57262
WELDED JOINTS/STRESS RELAXATION
Transient and residual stresses from multipass weld in very thick plates and their reduction from stress relief annealing, 2:57262
WELDS
See WELDED JOINTS
WELL CASINGS/CATHODIC PROTECTION
Computing methods for designing cathodic protection systems for elongate structures, 2:55798
WELL CASINGS/CORROSION PROTECTION
Study to improve downhole equipment for high-pressure gas wells, 2:55806
WELL CASINGS/EMPLACEMENT
Deviated conductor driving system (Patent), 2:55758
WEST VALLEY PROCESSING PLANT/RADIOACTIVE WASTE MANAGEMENT
Waste trench cap study of remedial work for West Valley, 2:55925
West Valley waste burial area problems correlated to operating practices, 2:55924
WILD ANIMALS/ECOLOGY
Strip-mining and small mammals in southern Iowa (36 refs), 2:55671 (IS-ICP-44)
WIND POWER/AVAILABILITY
Wind energy mission analysis. Executive summary (USA), 2:56219 (TID-27698)
WIND POWER/FEASIBILITY STUDIES
Report on the Western Energy Expansion Study, 2:56986 (NP-22295)
WIND POWER PLANTS/ECONOMICS
Status of wind energy conversion systems (WECS) for electric utility power generation, 2:56220
Wind energy mission analysis. Executive summary (USA), 2:56219 (TID-27698)
WIND POWER PLANTS/FEASIBILITY STUDIES
Wind energy mission analysis. Executive summary (USA), 2:56219 (TID-27698)
WIND POWER PLANTS/SITE SELECTION
Estimating wind power potential, 2:56226
WIND TURBINES
See also VERTICAL AXIS TURBINES
Aeolian windmill (Patent), 2:56224
WIND TURBINES/AIR CONDITIONERS
Temperature control system utilizing naturally occurring energy sources (Patent), 2:56221
WIND TURBINES/INSTALLATION
Look at vocational training for the solar energy industry, 2:56109
WIND TURBINES/MAINTENANCE
Look at vocational training for the solar energy industry, 2:56109
WIND TURBINES/RESEARCH PROGRAMS
Status of wind energy conversion systems (WECS) for electric utility power generation, 2:56220
WIND TURBINES/TURBINE BLADES
Rotor for wind-driven machine (Patent), 2:56223
WINE
See BEVERAGES
WINSTON COLLECTORS
See COMPOUND PARABOLIC CONCENTRATORS
WISCONSIN/AIR POLLUTION
Mesoscale air pollution transport in southeast Wisconsin. Final report 1972-1976, 2:57361 (PB-265382)
WNP-1 REACTOR/REACTOR SAFETY
Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I-VI, 2:56787 (ORNL/NUREG/NSIC-136)
WNP-2 REACTOR/REACTOR SAFETY
Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I-VI, 2:56787 (ORNL/NUREG/NSIC-136)
WORKERS
See PERSONNEL
WORKING FLUIDS/TOXICITY
Toxicological evaluation of liquids proposed for use in direct contact liquid-liquid heat exchangers for solar heated and cooled buildings, 2:56097 (COO/2867-1)
WPPSS NUCLEAR PROJECT NO. 1
See WNP-1 REACTOR
WWER TYPE REACTORS/REACTOR INTERNALS
Neutron noise analysis as a diagnostic method of mechanical vibrations in WWER type reactor core components, 2:56425
WWER TYPE REACTORS/REACTOR KINETICS
Complex solution of linear dynamics of WWER-44o nuclear power plant, 2:56426

WWER TYPE REACTORS/REACTOR NOISE
Neutron noise analysis as a diagnostic method of mechanical vibrations in WWER type reactor core components, 2:56425

X

XENON 132/NUCLEAR STRUCTURE
Emission of protons in $\pi^+ + Xe$ interactions at 2.34 GeV/c and Fermi motion of neutrons inside the nucleus, 2:57598
XENON 132 TARGET/PION PLUS REACTIONS
Emission of protons in $\pi^+ + Xe$ interactions at 2.34 GeV/c and Fermi motion of neutrons inside the nucleus, 2:57598
X-RAY RADIOGRAPHY/MATHEMATICAL MODELS
Assessment of thick section radiography. Final report, 2:57307 (EPRI-NP-461)
X-RAY SPECTROMETERS/SENSITIVITY
MOS solid-state detector arrays for x-ray imaging (For plasma diagnostics), 2:57336 (UCRL-79376)
X-RAY TUBES/DESIGN
Two-electrode pulsed x-ray tube (Patent), 2:55970 (SAND-77-6013)
XYLENE-PARA/PRODUCTION
Manufacture of hydrocarbons (Patent), 2:55982
Manufacture of hydrocarbons (Patent), 2:55986

Y

YELLOW CREEK-1 REACTOR/REACTOR SAFETY
Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I-VI, 2:56787 (ORNL/NUREG/NSIC-136)
YELLOW CREEK-2 REACTOR/REACTOR SAFETY
Design data and safety features of commercial nuclear power plants including cumulative index for Volumes I-VI, 2:56787 (ORNL/NUREG/NSIC-136)
YTTRIUM ALLOYS/OXIDATION
Oxidation behavior of nickel-chromium-aluminum-yttrium - magnesium oxide and nickel-chromium-aluminum-yttrium - zirconate type of cermets, 2:57163 (N-77-16115)
YTTRIUM COMPLEXES/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance studies of diamagnetic metal-aminopolycarboxylate complexes, 2:57229
YUGOSLAVIA/NATURAL GAS DEPOSITS
Calculation of oil and solution and free gas initially in place and their recovery during exploration, 2:55749
YUGOSLAVIA/PETROLEUM DEPOSITS
Calculation of oil and solution and free gas initially in place and their recovery during exploration, 2:55749

Z

ZERO POWER REACTORS/TABLES
Nuclear reactors built, being built, or planned in the United States as of June 30, 1977, 2:56362 (TID-8200-R36)
ZINC/BIOLOGICAL ACCUMULATION
Copper granules in the barnacle Balanus balanoides, 2:57452
ZINC/ECOLOGICAL CONCENTRATION
Fate of nuclides in natural water systems. Annual progress report, October 1, 1976-September 30, 1977 (Natural ^{234}Th and ^{210}Po tracer studies of trace metal cycling in coastal waters), 2:57353 (COO-3573-26)
ZINC/ENVIRONMENTAL TRANSPORT
Biogeochemistry of trace metals in Chesapeake Bay. Progress report, 1 July 1976-30 June 1977 (Comparison with San Francisco Bay), 2:57391 (COO-3292-28)
ZINC 65/TISSUE DISTRIBUTION
Binders of intravenously administered 65-zinc in rat liver cytoplasm, 2:57440 (N-77-16683)
ZINC ALLOYS/LATENT HEAT STORAGE
Thermal storage in metals, 2:56160
ZINC ALLOYS/THERMODYNAMIC PROPERTIES
Thermal storage in metals, 2:56160
ZINC CHLORIDES/CHEMICAL REACTIONS
Reactions of zinc chloride and coal (23 refs), 2:55632 (CONF-760885-)
ZINC COMPOUNDS/CATALYTIC EFFECTS
Molding of a low-temperature catalyst for methanol synthesis, 2:55995
ZINC ORES/RESERVES
Canadian reserves of seven metals, 2:56933
ZINC OXIDES/WETTABILITY
Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R-1746)
ZIRCALOY/ELECTROPOLISHING
Device for continuous electrolytic polishing of rod-shaped work pieces of zirconium alloys (Patent), 2:56712
ZIRCALOY/OXIDATION
Behavior of inner surface oxidation of the zircaloy cladding tube in a loss-of-coolant accident (BWR, PWR), 2:56783 (JAERI-M-6602)
ZIRCALOY 4/OXIDATION
Oxygen concentration distribution in β-phase of the Zry-4 cladding during Zr-steam reaction at LOCA, 2:56781 (JAERI-M-6538)
ZIRCONATES/OXIDATION
Oxidation behavior of nickel-chromium-aluminum-yttrium - magnesium oxide and nickel-chromium-aluminum-yttrium - zirconate type of cermets, 2:57163 (N-77-16115)
ZIRCONIUM 95/RADIOECOLOGICAL CONCENTRATION
Concentrations of radionuclides and selected stable elements in fruits and vegetables, 2:57381 (CONF-770676-1)
ZIRCONIUM ALLOYS
See also ZIRCONIUM BASE ALLOYS
ZIRCONIUM ALLOYS/CORROSION
Corrosion of iron-base alloys by lithium, 2:57134 (CONF-760503-P2)
ZIRCONIUM BASE ALLOYS
See also ZIRCALOY
ZIRCONIUM BASE ALLOYS/PHYSICAL RADIATION EFFECTS
Microstructure, deformation, and fracture behavior of reactor core materials, 2:56653
ZIRCONIUM CARBIDES/WETTABILITY
Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R-1746)
ZIRCONIUM OXIDES/WETTABILITY
Wetting properties of solid oxides and carbides by liquid metals, 2:57157 (AERE-M/R-1746)

REPORT NUMBER INDEX

The numbers assigned to all reports cited in the publication appear in the first column of the index. The citation numbers are included in the second column. Cross reference information and/or availability are included as appropriate. Abbreviations used in the availability column are elaborated at the end of the index.

Report No.	*Abstract No.*	*Availability*
A-		
184	2:56092	*See* PB-265105
AD-A-		
037488	2:57282	NTIS PCA02/MF A01
037663	2:57674	NTIS PCA06/MF A01
037734	2:57283	NTIS PCA09/MF A01
037760	2:57100	NTIS PCA04/MF A01
037761	2:57766	NTIS PCA03/MF A01
037807	2:56969	NTIS PCA03/MF A01
037827	2:57072	NTIS PCA03/MF A01
AD-D-		
003508	2:55629	NTIS PCA02/MF A01
003515	2:57265	NTIS PCA02/MF A01
AEC-tr-		
7297/9	2:57089	Dep. NTIS, PC A10/MF A01
AED-CONF-		
76-203-006	2:56897	Dep. NTIS (US Sales Only), $3.50
76-377-002	2:56883	Dep. NTIS (US Sales Only), PC A03/MF A01
76-417-001	2:55669	Dep. NTIS (US Sales Only), PC A03/MF A01
76-556-004	2:57140	Dep. NTIS (US Sales Only), PC A02/MF A01
76-556-013	2:56764	Dep. NTIS (US Sales Only), PC A02/MF A01
AEEW-R-		
1090	2:56474	Dep. NTIS (US Sales Only), PC A02/MF A01
AERE-M/R-		
1746	2:57157	Dep. NTIS (US Sales Only), PC A03/MF A01
ANL-		
76-130	2:56766	AT
77-3	2:57501	Dep. NTIS, PC A04/MF A01
77-39	2:57002	Dep. NTIS, PC A03/MF A01
8067	2:56475	Dep. NTIS, PC A04/MF A01
ANL-AMD-TM-		
191	2:57805	Dep. NTIS, PC A03/MF A01
282(Rev.)	2:57806	Dep. NTIS, PC A02/MF A01
283(Rev.)	2:57807	Dep. NTIS, PC A02/MF A01
ANL-CT-		
77-30	2:56476	AT
ANL/NDM-		
33	2:57591	Dep. NTIS, PC A03/MF A01
ARH-		
2127	2:55879	Dep. NTIS, PC A09/MF A01
ARH-SA-		
278	2:57375	Dep. NTIS, PC A02/MF A01
292	2:57397	Dep. NTIS, PC A04/MF A01
ARH-ST-		
131	2:57199	Dep. NTIS, PC A03/MF A01
ASHRAE/GRP-		
153	2:57004	*See* PB-264904
BDX-		
613-1295(Rev.)	2:57314	Dep. NTIS, PC A02/MF A01
BERC/RI-		
76/14	2:57206	Dep. NTIS, PC A04/MF A01
BMI-NUREG-		
1968	2:56767	Dep. NTIS, PC A04/MF A01
1969	2:56768	Dep. NTIS, PC A02/MF A01
BMI-X-		
683	2:55973	Dep. NTIS, PC A04/MF A01
BNL-		
22730	2:56954	Dep. NTIS, PC A03/MF A01
22759	2:57785	Dep. NTIS, PC A02/MF A01
22785	2:55981	Dep. NTIS, PC A03/MF A01
22811	2:57200	Dep. NTIS, PC A03/MF A01
22982	2:57209	Dep. NTIS, PC A02/MF A01
22993	2:57243	Dep. NTIS, PC A02/MF A01
23016	2:57107	NTIS, MF A01
23053	2:57125	Dep. NTIS, PC A02/MF A01
50600	2:57390	Dep. NTIS, PC A03/MF A01
50634	2:56915	Dep. NTIS, PC A04/MF A01
50637	2:57352	Dep. NTIS, PC A02/MF A01
BNL-NCS-		
50545(Vol.1)	2:57588	Dep. NTIS, PC A19/MF A01
50545(Vol.2)	2:57589	Dep. NTIS, PC A19/MF A01
BNWL-		
2122	2:56236	Dep. NTIS, PC A06/MF A01
2192	2:56194	Dep. NTIS, PC A04/MF A01
2227	2:57398	Dep. NTIS, PC A06/MF A01
2239	2:56427	Dep. NTIS, PC A04/MF A01
2268	2:56237	Dep. NTIS, PC A04/MF A01
2298	2:56916	Dep. NTIS, PC A02/MF A01
BNWL-SA-		
5855	2:57436	Dep. NTIS, PC A02/MF A01
5975(Rev.)	2:57379	Dep. NTIS, PC A02/MF A01
6055	2:55555	Dep. NTIS, PC A02/MF A01
6089	2:57387	Dep. NTIS, PC A02/MF A01
Bull-		
26	2:57359	*See* PB-265101
C-		
504-6-2	2:57356	*See* PB-264362
CA/DOH/AIHL/SP-		
5	2:57358	*See* PB-264823
CALSPAN-ZM-		
5793-V-2	2:57073	*See* PB-264516
CALT-		
767P6-X12	2:57406	Dep. NTIS, PC A02/MF A01
767P8-7	2:57210	Dep. NTIS, $4.00
822-88	2:57126	Dep. NTIS, PC A03/MF A01
822-91	2:57127	Dep. NTIS, PC A02/MF A01
822-95	2:57101	Dep. NTIS, PC A02/MF A01
CENPD-		
182(Pt.1)	2:56769	Combustion Engineering, Inc., Windsor, CT
182(Pt.2)	2:56770	Combustion Engineering, Inc., Windsor, CT
CONF-740349-		(167. national meeting of the American Chemical Society, Los Angeles, California, USA, 31 Mar-5 Apr 1974)
P6	2:57224	American Chemical Society (1975).
CONF-750269-		(2. National Institute of Radiological Sciences seminar, Chiba, Japan, 28 Feb 1975)
	2:57400	*See* NIRS-M-10

Report No.	Abstract No.	Availability
CONF-7504129-		(87. Battery Council International convention, Hollywood, Florida, United States of America (USA), 8-10 Apr 1975)
	2:56889	Battery Council International (1975).
CONF-750705-		(9. international conference on physics of electronic and atomic collisions, Seattle, Washington, USA, 24-30 Jul 1975)
	2:57517	University of Washington Press (1976). $40.00
CONF-751005-		(7. national SAMPE technical conference, Albuquerque, New Mexico, USA, 14-16 Oct 1975)
14	2:56099	*See* SAND-75-5880
CONF-751030-		(International nuclear industries fair, Basel, Switzerland, 7-11 Oct 1975)
12	2:56541	*See* TRG-Report-2819(D)
CONF-7511130-		(Conference on coal energy, Washington, District of Columbia, United States of America (USA), 21 Nov 1975)
1	2:55730	Wallace Wilson, Continental Illinois National Bank and Trust Co. of Chicago, IL
CONF-7511132-		(Technical committee meeting on recognition and evaluation of Uraniferous areas, Vienna, Austria, 17-21 Nov 1975)
	2:55855	*See* STI/PUB-450
CONF-751234-		(Meeting of electrocatalysis on non-metallic surfaces, Gaithersburg, Maryland, United States of America (USA), 9-12 Dec 1975)
2	2:57129	*See* IS-M-96
CONF-760396-		(9. meeting of the international working group on fast reactors, Vienna, Austria, 30 Mar-2 Apr 1976)
(Summ.)	2:56538	*See* IWGFR-12
CONF-760503-		(International conference on liquid metal technology in energy production, Champion, Pennsylvania, United States of America (USA), 3-6 May 1976)
P1	2:56477	Dep. NTIS, $12.00
P2	2:56529	Dep. NTIS, PC A20/MF A01
CONF-7605150-		(Conference on the spread of nuclear technology, Windsor, United Kingdom of Great Britain and Northern Ireland (UK), 26-27 May 1976)
1	2:55954	Dep. NTIS, PC A03/MF A01
CONF-7605158-		(International meeting on modern ceramic technology, Rimini, Italy, 26-31 May 1976)
1	2:57032	*See* COO-2390-15
CONF-7605159-		(Symposium on the handling of toxicological information, Bethesda, Maryland, United States of America (USA), 27-28 May 1976)
1	2:57460	Dep. NTIS, PC A02/MF A01
CONF-7605160-		(1. symposium on management of residuals from synthetic fuels production, Denver, Colorado, United States of America (USA), 25-27 May 1976)
1	2:55833	Dep. NTIS, PC A02/MF A01
CONF-760690-		(3. international conference and exhibition: research-technology-economics (Interocean 76), Duesseldorf, German, Federal Republic of (F.R. Germany), 15 Jun 1976)
1	2:56897	*See* AED-CONF-76-203-006
CONF-7606138-		(12. southeastern seminar on thermal sciences, Charlottesville, Virginia, United States of America (USA), 6-8 Jun 1976)
1	2:56090	*See* COO-4041-2
CONF-7606151-		(Seminar on the economic viability of nuclear energy, Washington, District of Columbia, United States of America (USA), 7 Jun 1976)
	2:56590	Scientists' Institute for Public Information, New York, NY N
CONF-760842-		(Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc., Winnipeg, Manitoba, Canada, 15-20 Aug 1976)
P6	2:56059	American Section of the International Solar Energy Society (1976).
P8	2:56016	American Section of the International Solar Energy Society (1976).
CONF-760885-		(Coal chemistry workshop, Menlo Park, California, United States of America (USA), 26-27 Aug 1976)
	2:55630	Dep. NTIS, PC A11/MF A01
CONF-7608101-		(Workshop on the measure of intangible environmental impacts, Pacific Grove, California, United States of America (USA), 3-6 Aug 1976)
	2:57403	*See* EPRI-EA-405-SR
CONF-7609137-		(Annual meeting of process engineers, Duesseldorf, German, Federal Republic of (F.R. Germany), 29 Sep 1976)
1	2:55669	*See* AED-CONF-76-417-001
CONF-7609138-		(Technical meeting on radiation exposure and damage of reactor components outside the reactor core, Stuttgart, German, Federal Republic of (F.R. Germany), 23 Sep 1976)
	2:56764	*See* AED-Conf-76-556-013
	2:57140	*See* AED-Conf-76-556-004
CONF-7609142-		(International geological correlation program: standards for computer applications in resource studies, Loen, Norway, 27 Sep-1 Oct 1976)
1	2:56169	*See* LBL-6305
CONF-7609147-		(Annual meeting of the Deutsche Gesellschaft fuer Luft- und Raumfahrt e.V., Munich, German, Federal Republic of (F.R. Germany), 14 Sep 1976)
2	2:56883	*See* AED-CONF-76-377-002
CONF-7609153-		(Symposium on coal geology and the future, Reston, Virginia, USA, 27-28 Sep 1976)
(Absts.)	2:55547	*See* USGS-CIRC-757
CONF-761012-		(6. international conference on plasma physics and controlled nuclear fusion research, Berchtesgaden, German, Federal Republic of (F.R. Germany), 6-13 Oct 1976)
P1	2:57687	*See* STI/PUB-439(Vol.1)
P2	2:57688	*See* STI/PUB-439(Vol.2)
P3	2:57689	*See* STI/PUB-439(Vol.3)
CONF-761028-		(ERDA contractor's coordination meeting, Ann Arbor, Michigan, United States of America (USA), 17-20 Oct 1976)
4	2:57074	Dep. NTIS, PC A02/MF A01
CONF-761065-		(Symposium on dynamics of transuranics in terrestrial and aquatic environments, Gatlinburg, Tennessee, United States of America (USA), 5-7 Oct 1976)
8	2:57379	*See* BNWL-SA-5975(Rev.)
CONF-7610109-		(25. congress and plenary assembly of CIESM, Split, Yugoslavia, 22-30 Oct 1976)
1	2:57399	*See* RLO-2231-T1-9
CONF-761123-		(Advisory group meeting on atomic and molecular data for fusion, Abingdon, Oxfordshire, United Kingdom of Great Britain and Northern Ireland (UK), 1-5 Nov 1976)
4	2:57832	*See* UCRL-79286
CONF-761130-		(12. IEEE photovoltaic specialists conference, Baton Rouge, Louisiana, United States of America (USA), 15-18 Nov 1976)
4	2:56028	Dep. NTIS, PC A02/MF A01
CONF-761229-		(Fall meeting of the American Geophysical Union, San Francisco, California, United States of America (USA), 6-10 Dec 1976)
2	2:57375	*See* ARH-SA-278
CONF-761234-		(International symposium on biological application of stable isotopes, Leipzig, German, Federal Republic of (F.R. Germany), 6-10 Dec 1976)
3	2:57407	Dep. NTIS, PC A02/MF A01
CONF-770115-		(15. international winter meeting on nuclear physics, Bormio, Italy, 17-21 Jan 1977)
1	2:57597	Dep. NTIS, PC A02/MF A01
CONF-770211-		(ACM/IEEE symposium on design automation and microprocessors, Palo Alto, California, United States of America (USA), 24-25 Feb 1977)
3	2:57821	*See* UCLA-34P214-42
5	2:57819	*See* UCLA-34P214-37
7	2:57820	*See* UCLA-34P214-40
CONF-770225-		(4. annual meeting of the Midsouth Academy of Economists, Memphis, Tennessee, United States of America (USA), 10-12 Feb 1977)
1	2:57013	Dep. NTIS, PC A02/MF A01

Report No.	Abstract No.	Availability
CONF-770228-		(Symposium on stress effects on natural ecosystems, Columbus, Ohio, United States of America (USA), 4-5 Feb 1977)
1	2:57376	Dep. NTIS, PC A03/MF A01
CONF-770309-		(Conference on fracture mechanics and technology, Hong Kong, China, 21-25 Mar 1977)
2	2:57252	*See* UCRL-78367
CONF-770324-		(3. international conference on impulse cytophotometry, Vienna, Austria, 30 Mar-1 Apr 1977)
3	2:57416	*See* LA-UR-77-365
4	2:57417	*See* LA-UR-77-992
CONF-770331-		(4. ocean thermal energy conversion conference, New Orleans, Louisiana, United States of America (USA), 22-24 Mar 1977)
5	2:56089	Dep. NTIS, PC A02/MF A01
CONF-770332-		(9. annual symposium on advanced analytical concepts for the clinical laboratory, Oak Ridge, Tennessee, United States of America (USA), 18-19 Mar 1977)
1	2:57201	Dep. NTIS, PC A03/MF A01
CONF-770342-		(Symposium on mechanisms of tumor promotion and cocarcinogensis, Gatlinburg, Tennessee, United States of America (USA), 28-31 Mar 1977)
2	2:57453	Dep. NTIS, PC A03/MF A01
CONF-770346-		(Symposium on excited states in organic and biochemistry, Jerusalem, Israel, 28-31 Mar 1977)
1	2:57408	Dep. NTIS, PC A02/MF A01
CONF-770349-		(11. annual conference on information sciences and systems, Baltimore, Maryland, United States of America (USA), 30 Mar-1 Apr 1977)
1	2:57824	*See* UCRL-79308
CONF-770350-		(US/USSR workshop on hybrid reactor design, Moscow, Union of Soviet Socialist Republics (USSR), 14 Mar-2 Apr 1977)
1	2:57690	*See* UCRL-79548
CONF-770354-		(1. technical meeting on the nuclear transmutation, Ispra, Italy, 16-18 Mar 1977)
1	2:55898	Dep. NTIS, PC A02/MF A01
CONF-770359-		(Energy Environment conference, Kansas City, Missouri, USA, 29 Mar 1977)
1	2:56096	Kaman Sciences Corp., Colorado Springs, CO
CONF-770360-		(Ports '77 specialty conference of the American Society of Civil Engineers, Long Beach, California, USA, 9-11 Mar 1977)
1	2:55814	Institute of Gas Technology, Chicago, IL
CONF-770401-		(5. international conference on reactor shielding, Knoxville, Tennessee, United States of America (USA), 18-22 Apr 1977)
5	2:56651	Dep. NTIS, PC A02/MF A01
CONF-770403-		(39. annual meeting of the American Power Conference, Chicago, Illinois, United States of America (USA), 18-20 Apr 1977)
15	2:56608	NTIS, MF A01
CONF-770409-		(4. congress of the International Radiation Protection Agency, Paris, France, 24-30 Apr 1977)
9	2:57436	*See* BNWL-SA-5855
CONF-770411-		(Conference on high temperature sciences related to open-cycle coal fired MHD systems, Argonne, Illinois, United States of America (USA), 4-6 Apr 1977)
2	2:55650	*See* UCRL-79146
CONF-770413-		(Symposium on high speed computer and algorithm organization, Urbana, Illinois, United States of America (USA), 13-15 Apr 1977)
4	2:57823	*See* UCRL-79287
CONF-770414-		(3. international conference on pressure vessel technology, Tokyo, Japan, 19-22 Apr 1977)
P1	2:56667	American Society of Mechanical Engineers (1977). $75.00
P2	2:56671	American Society of Mechanical Engineers (1977). $75.00
CONF-770419-		(10. oil shale symposium, Golden, Colorado, United States of America (USA), 21-22 Apr 1977)
3	2:55836	*See* UCRL-79034
CONF-770434-		(SPIE x-ray imaging symposium, Reston, Virginia, United States of America (USA), 20-21 Apr 1977)
1	2:57336	*See* UCRL-79376
5	2:57635	NTIS, MF A01
6	2:57636	Dep. NTIS, PC A04/MF A01
CONF-770439-		(High efficiency radiation damage silicon solar cell meeting, Cleveland, Ohio, United States of America (USA), 28-29 Apr 1977)
1	2:56029	Dep. NTIS, PC A02/MF A01
CONF-770440-		(American Nuclear Society topical meeting on energy and mineral recovery research, Golden, Colorado, United States of America (USA), 12-14 Apr 1977)
2	2:55837	*See* UCRL-79149
9	2:55831	*See* SAND-77-0422C
CONF-770441-		(American Nuclear Society executive seminar on nuclear energy centers, Arlington, Virginia, United States of America (USA), 26 Apr 1977)
2	2:56361	Dep. NTIS, PC A03/MF A01
CONF-770446-		(Conference on detection of forgery in the arts, Philadelphia, Pennsylvania, United States of America (USA), 27-29 Apr 1977)
1	2:57200	*See* BNL-22811
CONF-770510-		(American Chemical Society meeting, Montreal, Canada, May 1977)
5	2:57209	*See* BNL-22982
6	2:55560	Dep. NTIS, PC A02/MF A01
7	2:55561	Dep. NTIS, PC A02/MF A01
8	2:55562	Dep. NTIS, PC A02/MF A01
CONF-770513-		(Electronic component conference, Arlington, Virginia, United States of America (USA), 17 May 1977)
3	2:57173	*See* SAND-76-5854C
CONF-770520-		(International powder and bulk solids handling and processing conference/ exhibition, Rosemont, Illinois, United States of America (USA), May 1977)
2	2:57181	*See* LA-UR-77-1098
CONF-770523-		(Symposium on neutron cross sections 10-40 MeV, Upton, New York, United States of America (USA), 3-5 May 1977)
6	2:57788	*See* LA-UR-77-1033
CONF-770530-		(16. engineering aspects of MHD symposium, Pittsburgh, Pennsylvania, United States of America (USA), 16-18 May 1977)
2	2:55722	Dep. NTIS, PC A02/MF A01
CONF-770531-		(Meeting of the Electrochemical Society, Philadelphia, Pennsylvania, United States of America (USA), 8-13 May 1977)
8	2:57000	*See* ERDA/NASA/1002-77/ 10
CONF-770537-		(7. symposium on thermophysical properties, Gaithersburg, Maryland, United States of America (USA), 10-12 May 1977)
2	2:55867	Dep. NTIS, PC A03/MF A01
4	2:57128	Dep. NTIS, PC A02/MF A01
CONF-770552-		(97. annual conference of the American Water Works Association, Anaheim, California, United States of America (USA), 8-13 May 1977)
1	2:57388	Dep. NTIS, PC A02/MF A01
CONF-770555-		(Cold Spring Harbor symposium, Cold Spring Harbor, New York, United States of America (USA), 12-15 May 1977)
1	2:57409	Dep. NTIS, PC A02/MF A01
2	2:57410	Dep. NTIS, PC A03/MF A01
CONF-770557-		(4. international clean air congress, Tokyo, Japan, 16-20 May 1977)
2	2:57459	Institute of Gas Technology, Chicago, IL
CONF-770560-		(Public meeting to review the status of the inexhaustible energy resources study, Washington, District of Columbia, United States of America (USA), 18 May 1977)
	2:56985	Dep. NTIS, PC A04/MF A01
CONF-770566-		(Ohio section meeting American Physical Society, Dayton, Ohio, United States of America (USA), 6-7 May 1977)
1	2:56652	*See* MLM-2426(OP)
CONF-770571-		(Anomalous absorption conference, Vancouver, British Columbia, Canada, 10-12 May 1977)

Report No.	Abstract No.	Availability
1	2:57676	*See* UCRL-79604
2	2:57772	*See* UCRL-79628
CONF-770575-	(25. annual conference on mass spectrometry and allied topics, Washington, District of Columbia, USA, 29 May-3 Jun 1977)	
3	2:57202	*See* GAT-T-2657
CONF-770577-	(American Gas Association Distribution conference, New Orleans, Louisiana, USA, 2-4 May 1977)	
1	2:55817	Institute of Gas Technology, Chicago, IL
CONF-770610-	(14. ACM-IEEE design automation conference, New Orleans, Louisiana, United States of America (USA), 20-22 Jun 1977)	
1	2:57827	*See* UCRL-79426
CONF-770611-	(American Nuclear Society annual meeting, New York, New York, United States of America (USA), 12-17 Jun 1977)	
6	2:56530	Dep. NTIS, PC A02/MF A01
26	2:57275	*See* DP-MS-77-5
CONF-770615-	(National conference on campus safety on the University of Hawaii Campus, Honolulu, Hawaii, United States of America (USA), 9-16 Jun 1977)	
2	2:57428	NTIS, MF A01
CONF-770617-	(Colorado School of Mines meeting, Keystone, Colorado, United States of America (USA), 21-23 Jun 1977)	
1	2:55832	*See* SAND-77-0779C
CONF-770619-	(International symposium on computer methods for partial differential equations, Bethlehem, Pennsylvania, United States of America (USA), 22-24 Jun 1977)	
3	2:57826	*See* UCRL-79328(Pt.1)
4	2:57825	*See* UCRL-79316(Rev.1)
CONF-770621-	(SAPuusers conference, Los Angeles, California, United States of America (USA), 20-24 Jun 1977)	
2	2:57808	*See* GA-A-14405
CONF-770625-	(International conference on nuclear systems reliability engineering and risk assessment, Gatlinburg, Tennessee, United States of America (USA), 20-24 Jun 1977)	
3	2:56771	Dep. NTIS, PC A03/MF A01
CONF-770629-	(Conference on laser engineering and applications, Washington, District of Columbia, United States of America (USA), 1-3 Jun 1977)	
2	2:57284	*See* SAND-76-9300
3	2:57285	*See* SAND-76-9310
4	2:57767	*See* COO-2007-82
5	2:57771	*See* UCRL-79540
CONF-770634-	(22. American Scientific Glassblowers symposium, Boston, Massachusetts, United States of America (USA), 19-23 Jun 1977)	
1	2:57250	Dep. NTIS, PC A02/MF A01
CONF-770635-	(Conference on the standardization of safety and performance tests for energetic materials, Dover, New Jersey, United States of America (USA), 21-23 Jun 1977)	
3	2:57346	*See* LA-UR-77-1378
4	2:57349	*See* UCRL-79391
CONF-770642-	(3. international conference on ion beam analysis, Washington, District of Columbia, United States of America (USA), 27 Jun-1 Jul 1977)	
4	2:57189	*See* SAND-77-0366C
5	2:57190	*See* SAND-77-0424C
CONF-770647-	(Symposium on terrestrial microcosms and environmental chemistry, Corvallis, Oregon, United States of America (USA), 13-17 Jun 1977)	
1	2:57380	Dep. NTIS, PC A02/MF A01
CONF-770648-	(Cold Spring Harbor symposium on quantitative biology, Cold Spring Harbor, New York, United States of America (USA), 1-8 Jun 1977)	
1	2:57411	Dep. NTIS, PC A03/MF A01
2	2:57412	Dep. NTIS, PC A02/MF A01
CONF-770649-	(International discussion meeting of radiation effects in superconductors, Argonne, Illinois, United States of America (USA), 13-16 Jun 1977)	
1	2:57141	Dep. NTIS, PC A03/MF A01
4	2:57125	*See* BNL-23053
CONF-770655-	(Coal feeding systems conference, Pasadena, California, United States of America (USA), 21-23 Jun 1977)	
1	2:55563	Dep. NTIS, PC A02/MF A01
CONF-770656-	(Annual meeting of the Institute of Nuclear Materials Management, Washington, District of Columbia, United States of America (USA), 29 Jun-1 Jul 1977)	
4	2:57384	*See* UCRL-79214(Rev.1)
9	2:55962	*See* SAND-77-0980C
13	2:55961	*See* SAND-77-0890C
14	2:55966	*See* UCRL-79214
CONF-770669-	(National computer conference, Dallas, Texas, USA, 13-16 Jun 1977)	
1	2:57828	*See* UCRL-79581
CONF-770672-	(Society for Women Engineers conference, Cincinnati, Ohio, USA, 23-25 Jun 1977)	
1	2:57273	*See* MLM-2438(OP)
CONF-770673-	(24. annual meeting of the Society of Nuclear Medicine, Chicago, Illinois, USA, 23 Jun 1977)	
1	2:57439	Dep. NTIS, PC A02/MF A01
2	2:57243	*See* BNL-22993
CONF-770676-	(11. annual conference on trace substances in environmental health, Columbia, Missouri, USA, 7-9 Jun 1977)	
1	2:57381	Dep. NTIS, PC A02/MF A01
CONF-770706-	(6. AIRAPT international high-pressure conference, Boulder, Colorado, United States of America (USA), 25-29 Jul 1977)	
4	2:57253	*See* UCRL-78886
12	2:57474	*See* UCRL-79011
13	2:57175	*See* SAND-77-0104C
14	2:57113	*See* LA-UR-77-1292
15	2:57156	*See* SAND-77-1056C
16	2:57117	*See* SAND-77-0027C
17	2:57118	*See* UCRL-79712
18	2:57106	*See* UCRL-79032
CONF-770708-	(Thermal reactor safety meeting, Sun Valley, Idaho, United States of America (USA), 31 Jul-5 Aug 1977)	
5	2:56428	Dep. NTIS, PC A02/MF A01
CONF-770720-	(22. annual meeting of the Health Physics Society, Atlanta, Georgia, USA, 3-8 Jul 1977)	
3	2:57382	*See* DP-MS-76-89
CONF-770723-	(Solar data users workshop, Albuquerque, New Mexico, USA, 7 Jul 1977)	
1	2:56023	*See* SAND-77-1047C
CONF-770801-	(Cryogenic engineering conference, Boulder, Colorado, United States of America (USA), 2-5 Aug 1977)	
15	2:57107	*See* BNL-23016
CONF-770804-	(12. intersociety energy conversion engineering conference, Washington, District of Columbia, United States of America (USA), 28 Aug-2 Sep 1977)	
4	2:55981	*See* BNL-22785
CONF-770807-	(4. international conference on structural mechanics in reactor technology, San Francisco, California, United States of America (USA), 15-19 Aug 1977)	
8	2:57109	Dep. NTIS, PC A02/MF A01
10	2:56796	*See* UCRL-79277
CONF-770812-	(International symposium on computer performance modeling, measurement, and evaluation, Yorktown Heights, New York, United States of America (USA), 16-18 Aug 1977)	
2	2:57811	*See* LA-UR-77-894
CONF-770813-	(ADINA conference, Cambridge, Massachusetts, United States of America (USA), 4-5 Aug 1977)	
3	2:57812	*See* LA-UR-77-1345
CONF-770814-	(American Chemical Society meeting, Chicago, Illinois, United States of America (USA), 29 Aug-2 Sep 1977)	
3	2:55564	Institute of Gas Technology, Chicago, IL
CONF-770903-	(ASME energy technology conference on composites in pressure vessels and piping, Houston, Texas, United States of America (USA), 18-22 Sep 1977)	
3	2:57308	*See* SAND-77-0526C

Report No.	Abstract No.	Availability
CONF-770906-		(8. European conference on controlled fusion and plasma physics, Prague, Czechoslovakia, 19-23 Sep 1977)
1	2:57661	*See* LA-UR-77-1142
CONF-770907-		(International solvent extraction conference, Toronto, Canada, 9-16 Sep 1977)
2	2:55881	*See* DP-MS-76-77
CONF-770908-		(7. international Vac. congress and 3. international conference on solid surfaces, Vienna, Austria, 12-16 Sep 1977)
3	2:57785	*See* BNL-22759
CONF-770913-		(International conference on lattice dynamics, Paris, France, 5-10 Sep 1977)
1	2:57623	*See* UCRL-79259
CONF-770914-		(Symposium on computers in chemical engineering, Vysoke Tatry, Czechoslovakia, Sep 1977)
1	2:57814	*See* SAND-76-5572
CONF-771004-		(6. international conference on chemical vapor deposition, Atlanta, Georgia, USA, 10-13 Oct 1977)
1	2:57164	*See* LA-UR-77-1261
CONF-771007-		(3. international conference on very large data bases, Tokyo, Japan, 6-8 Oct 1977)
1	2:57833	*See* UCRL-79357
CONS/2066-		
1	2:56355	Dep. NTIS, PC A06/MF A01
CONS/2103-		
1	2:55999	Dep. NTIS, PC A03/MF A01
2	2:56987	Dep. NTIS, PC A03/MF A01
3	2:56980	Dep. NTIS, PC A03/MF A01
4	2:56981	Dep. NTIS, PC A05/MF A01
6	2:57022	Dep. NTIS, PC A04/MF A01
CONS/3800-		
1	2:56360	Dep. NTIS, PC A05/MF A01
CONS/NSF/42-		
1	2:56884	Dep. NTIS, PC A11/MF A01
COO-		
0056-4	2:55600	Dep. NTIS, PC A02/MF A01
1198-1181	2:57102	Dep. NTIS, PC A08/MF A01
1599-120	2:57389	Dep. NTIS, PC A03/MF A01
2007-82	2:57767	Dep. NTIS, PC A02/MF A01
2012-27	2:57434	Dep. NTIS, PC A02/MF A01
2245-38	2:56531	Dep. NTIS, PC A04/MF A01
2390-15	2:57032	Dep. NTIS, PC A02/MF A01
2512-10	2:56532	Dep. NTIS, PC A02/MF A01
2727-5	2:57378	Dep. NTIS, PC A03/MF A01
2733-11	2:57110	Dep. NTIS, PC A02/MF A01
2780-3	2:57731	Dep. NTIS, PC A02/MF A01
2823-1	2:56085	Dep. NTIS, PC A03/MF A01
2899-1	2:57174	Dep. NTIS, PC A02/MF A01
2904-4	2:55565	Dep. NTIS, PC A04/MF A01
3017-31	2:57435	Dep. NTIS, PC A02/MF A01
3028-28	2:57786	Dep. NTIS, PC A10/MF A01
3077-137	2:57660	Dep. NTIS, PC A05/MF A01
3077-140	2:57251	Dep. NTIS, PC A05/MF A01
3077-145	2:57560	Dep. NTIS, PC A04/MF A01
3084-52	2:57111	Dep. NTIS, PC A03/MF A01
3150-39	2:57103	Dep. NTIS, PC A03/MF A01
3292-28	2:57391	Dep. NTIS, PC A04/MF A01
3573-26	2:57353	Dep. NTIS, PC A02/MF A01
4040-1	2:56772	Dep. NTIS, PC A02/MF A01
4041-2	2:56090	Dep. NTIS, PC A02/MF A01
4093-1	2:57787	Dep. NTIS, PC A02/MF A01
4246-1	2:57104	Dep. NTIS, PC A02/MF A01
COO/2604-		
76/1	2:56119	Dep. NTIS, PC A04/MF A01
COO/2867-		
1	2:56097	Dep. NTIS, PC A12/MF A01
CPG-		
1-5A	2:57835	Defense Civil Preparedness Agency, Washington, DC
CRBRP-ARD-		
0164	2:56755	AT
0166	2:56533	AT
CRBRP-PMC-		
77-03	2:56534	AT
CREARE-TN-		
255	2:56773	Dep. NTIS, PC A03/MF A01
DES-		
77/3	2:56961	*See* PB-265815
DLCS-		
5000177	2:56535	Dep. NTIS, PC A02/MF A01
DOCKET-50586-		
1	2:56581	
DOT-HS-		
802-147	2:57024	*See* PB-265387
DP-		
1429	2:55880	Dep. NTIS, PC A03/MF A01
DP-MS-		
76-77	2:55881	Dep. NTIS, PC A02/MF A01
76-89	2:57382	Dep. NTIS, PC A02/MF A01
77-5	2:57275	Dep. NTIS, PC A02/MF A01
DPST-		
76-254	2:55932	Dep. NTIS, PC A02/MF A01
77-128-6	2:55974	Dep. NTIS, PC A02/MF A01
77-138-2	2:55854	Dep. NTIS, PC A04/MF A01
DSE/2426-		
12	2:56091	Dep. NTIS, PC A02/MF A01
DSE/2531-		
2	2:56111	TIC
DTM-		
76-2	2:56119	*See* COO/2604-76/1
E-		
76-10453	2:57463	NTIS, $5.50
8834	2:57163	*See* N-77-16115
8929	2:56997	*See* N-77-16445
ECN-		
4	2:57142	Dep. NTIS (US Sales Only), PC A06/MF A01
9	2:56536	Dep. NTIS (US Sales Only), PC A03/MF A01
EEI-RP-		
90-2	2:56356	Edison Electric Inst., New York, NY
EF-		
76-18R	2:57357	*See* PB-264822
ENDF-		
243(Vol.1)	2:57588	*See* BNL-NCS-50545(Vol.1)
243(Vol.2)	2:57589	*See* BNL-NCS-50545(Vol.2)
249	2:57622	*See* ORNL/TM-5938
EPA-		
450/1-77-003	2:57354	GPO
570/9—77/002	2:56957	*See* PB-265364
600/2-77-048	2:57047	NTIS
600/9-77/002	2:56922	*See* PB-264529
625/1-76-001a	2:57207	Environmental Protection Agency, Washington, DC
EPRI-		
1234	2:55601	Dep. NTIS, PC A07/MF A01
EPRI-EA-		
405-SR	2:57403	Dep. NTIS, PC A08/MF A01
427-SR	2:56743	Dep. NTIS, PC A02/MF A01
462	2:56948	Dep. NTIS, PC A15/MF A01
EPRI-EL-		
453(6-77)	2:56349	Dep. NTIS, PC A04/MF A01
EPRI-ER-		
434	2:56088	Dep. NTIS, PC A04/MF A01
434(6-77)	2:56079	Dep. NTIS, PC A04/MF A01
451(Vol.1)(5-77)	2:57755	Dep. NTIS, PC A14/MF A01
451(Vol.2)(5-77)	2:57756	Dep. NTIS, PC A16/MF A01
478	2:56030	Dep. NTIS, PC A03/MF A01
EPRI-NP-		
461	2:57307	Dep. NTIS, PC A08/MF A01
EPRI-SR-		
36	2:55546	Dep. NTIS, PC A04/MF A01
38(Vol.1)	2:57401	Dep. NTIS, PC A07/MF A01
ERDA-		
76-28V1	2:57088	Dep. NTIS, PC A06/MF A01
76-162	2:55899	Dep. NTIS, PC A03/MF A01
77-46	2:55893	Dep. NTIS, PC A03/MF A01
77-51	2:55566	Dep. NTIS, PC A03/MF A01
77-75	2:55933	Dep. NTIS, PC A22/MF A01
ERDA/JPL/954144-		
77/1	2:56031	Dep. NTIS, PC A05/MF A01
ERDA/JPL/954331-		
77/2	2:56032	Dep. NTIS, PC A03/MF A01
ERDA/JPL/954339-		
77/1	2:56033	Dep. NTIS, PC A04/MF A01
ERDA/JPL/954343-		
77/2	2:56034	Dep. NTIS, PC A03/MF A01
ERDA/JPL/954344-		
77/1	2:56035	Dep. NTIS, PC A03/MF A01
ERDA/JPL/954350-		
77/1	2:56036	Dep. NTIS, PC A02/MF A01
ERDA/JPL/954352-		
77/1	2:56037	Dep. NTIS, PC A05/MF A01
ERDA/JPL/954442-		
77/2	2:56038	Dep. NTIS, PC A04/MF A01
ERDA/JPL/954471-		
77/1	2:56039	Dep. NTIS, PC A02/MF A01

Report No.	Abstract No.	Availability
ERDA/JPL/954521-		
77/2	2:56040	Dep. NTIS, PC A03/MF A01
ERDA/JPL/954559-		
77/1	2:56041	Dep. NTIS, PC A03/MF A01
ERDA/NASA/1002-		
77/10	2:57000	Dep. NTIS, PC A02/MF A01
ERDA/NASA/1022-		
77/10	2:56042	Dep. NTIS, PC A02/MF A01
77/13	2:56043	Dep. NTIS, PC A02/MF A01
ERDA-tr-		
273	2:56882	Dep. NTIS, PC A02/MF A01
296	2:55590	Dep. NTIS, PC A05/MF A01
ESA-CR(P)-		
832	2:56898	*See* N-77-10661
EUR-		
5507d	2:56537	*See* EURFNR-1437
EURFNR-		
1370	2:56878	Dep. NTIS, PC A08/MF A01
1400	2:56774	Dep. NTIS (US Sales Only), PC A04/MF A01
1437	2:56537	Dep. NTIS (US Sales Only), PC A10/MF A01
FE-		
496-129	2:55621	Dep. NTIS, PC A04/MF A01
496-134	2:55622	Dep. NTIS, PC A06/MF A01
496-T13	2:55623	Dep. NTIS, PC A20/MF A01
1207-29	2:55567	Dep. NTIS, PC A05/MF A01
1517-24	2:55602	Dep. NTIS, PC A03/MF A01
1521-51	2:55568	Dep. NTIS, PC A02/MF A01
1752-14	2:55603	Dep. NTIS, PC A04/MF A01
1752-15	2:55604	Dep. NTIS, PC A05/MF A01
1752-16	2:55605	Dep. NTIS, PC A05/MF A01
1752-18	2:55606	Dep. NTIS, PC A04/MF A01
1752-20	2:55607	Dep. NTIS, PC A04/MF A01
1752-21	2:55608	Dep. NTIS, PC A05/MF A01
1765-30	2:56250	Dep. NTIS, PC A03/MF A01
1775-10	2:55569	Dep. NTIS, PC A03/MF A01
1800-12	2:55609	Dep. NTIS, PC A05/MF A01
2003-18a	2:55712	Dep. NTIS, PC A04/MF A01
2010-01	2:55624	Dep. NTIS, PC A03/MF A01
2018-6	2:55723	Dep. NTIS, PC A02/MF A01
2018-7	2:55724	Dep. NTIS, PC A02/MF A01
2024-4	2:55570	Dep. NTIS, PC A02/MF A01
2031-7	2:55610	Dep. NTIS, PC A03/MF A01
2034-7	2:55556	Dep. NTIS, PC A05/MF A01
2046-1	2:55571	Dep. NTIS, PC A02/MF A01
2046-2	2:55572	Dep. NTIS, PC A02/MF A01
2210-12	2:55573	Dep. NTIS, PC A03/MF A01
2229-4	2:55574	Dep. NTIS, PC A05/MF A01
2233-2	2:55626	Dep. NTIS, PC A03/MF A01
2247-1	2:55611	Dep. NTIS, PC A02/MF A01
2251-14	2:55612	Dep. NTIS, PC A04/MF A01
2270-17	2:55625	Dep. NTIS, PC A03/MF A01
2290-27	2:56245	Dep. NTIS, PC A13/MF A01
2316-2	2:55642	Dep. NTIS, PC A03/MF A01
2325-14	2:55725	Dep. NTIS, PC A02/MF A01
2334-5	2:55557	Dep. NTIS, PC A02/MF A01
2341-1	2:56996	Dep. NTIS, PC A02/MF A01
2355-12(Rev.A)	2:55575	Dep. NTIS, PC A02/MF A01
2355-13	2:55576	Dep. NTIS, PC A06/MF A01
2355-14	2:55577	Dep. NTIS, PC A02/MF A01
2355-15	2:55578	Dep. NTIS, PC A04/MF A01
2355-16	2:55579	Dep. NTIS, PC A04/MF A01
2355-19	2:55580	Dep. NTIS, PC A03/MF A01
2356-20	2:55581	Dep. NTIS, PC A02/MF A01
2370-13	2:55582	Dep. NTIS, PC A03/MF A01
2412-T-1	2:55726	Dep. NTIS, PC A03/MF A01
2490-8	2:55983	Dep. NTIS, PC A02/MF A01
2537-2	2:55643	Dep. NTIS, PC A03/MF A01
2550-2	2:55613	Dep. NTIS, PC A03/MF A01
5302-5	2:55755	Dep. NTIS, $4.00
FEA/B-		
77/037	2:55783	*See* PB-263966
77/065	2:55784	*See* PB-264142
77/078	2:55782	*See* NTISUB/B-125-76/011
77/080	2:55785	*See* PB-264143
77/098	2:55786	*See* PB-264460
FEA/D-		
77/128	2:56975	*See* PB-265 641
FEA/G-		
77/061	2:56961	*See* PB-265815
77/105	2:56972	*See* PB-265143
FWC/FWEC/GQ-		
09	2:55568	*See* FE-1521-51
GA-A-		
14205	2:56775	Dep. NTIS, PC A05/MF A01
14381	2:56429	Dep. NTIS, PC A04/MF A01
14405	2:57808	Dep. NTIS, PC A02/MF A01
GAT-T-		
2657	2:57202	Dep. NTIS, PC A02/MF A01
GEFR-		
13923-18	2:56776	AT
14029-11	2:57112	AT
14034-10	2:56777	AT
GEPP-		
297	2:57090	Dep. NTIS, PC A04/MF A01
305	2:57170	Dep. NTIS, PC A02/MF A01
GJBX-		
43(77)	2:57196	Dep. NTIS, PC A03/MF A01
52(77)	2:57198	*See* LA-6869-MS
53-77	2:55856	*See* UCID-16911-77-1
55(77)	2:55854	*See* DPST-77-138-2
HEDL-TME-		
77-26	2:56778	AT
ICP-		
1122	2:55900	Dep. NTIS, PC A04/MF A01
IES-		
48	2:55851	Univ. of Wisconsin, Inst. for Environmental Studies, Madison, WI
IKE-		
6-104	2:56750	Dep. NTIS (US Sales Only), PC A04/MF A01
INIS-mf-		
3272	2:55934	Dep. NTIS (US Sales Only), PC A06/MF A01
IRI-		
33-76-02	2:57440	*See* N-77-16683
IRS-F-		
33	2:56779	Dep. NTIS (US Sales Only), PC A15/MF A01
IRS-W-		
24	2:56780	Dep. NTIS (US Sales Only), PC A07/MF A01
IS-		
4139	2:56756	Dep. NTIS, PC A04/MF A01
4169	2:57335	Dep. NTIS, PC A04/MF A01
IS-ICP-		
44	2:55671	Dep. NTIS, PC A02/MF A01
46	2:55731	Dep. NTIS, PC A03/MF A01
IS-M-		
96	2:57129	Dep. NTIS, PC A02/MF A01
IS-T-		
779	2:55553	Dep. NTIS, PC A06/MF A01
IWGFR-		
12	2:56538	Dep. NTIS (US Sales Only), PC A06/MF A01
JAERI-M-		
6538	2:56781	Dep. NTIS (US Sales Only), PC A03/MF A01
6539	2:56782	Dep. NTIS (US Sales Only), PC A03/MF A01
6592	2:55882	Dep. NTIS (US Sales Only), PC A03/MF A01
6597	2:56638	Dep. NTIS (US Sales Only), PC A02/MF A01
6602	2:56783	Dep. NTIS (US Sales Only), PC A02/MF A01
JPRS-		
69404	2:56410	NTIS
JSC-		
11568-V-1	2:56076	*See* N-77-16442
11568-V-2	2:56077	*See* N-77-16443
K/CSD/TM-		
13	2:57809	Dep. NTIS, PC A02/MF A01
14	2:57810	Dep. NTIS, PC A03/MF A01
K/DD-		
1000	2:57272	Dep. NTIS, PC A03/MF A01
KFK-		
2366	2:56774	*See* EURFNR-1400
2372	2:56537	*See* EURFNR-1437
KVB-		
6001/8300-461	2:57035	*See* PB-264543
KY-		
665(Suppl.1)	2:57276	Dep. NTIS, PC A03/MF A01
LA-		
6681-MS	2:57241	Dep. NTIS, PC A02/MF A01
6770	2:56982	Dep. NTIS, PC A04/MF A01
6808-PR	2:56539	Dep. NTIS, PC A02/MF A01
6809	2:57249	Dep. NTIS, PC A02/MF A01
6812-PR	2:57340	Dep. NTIS, PC A02/MF A01
6813-MS	2:56784	Dep. NTIS, PC A05/MF A01

Report No.	Abstract No.	Availability
6839-MS	2:55935	Dep. NTIS, PC A03/MF A01
6867	2:57203	Dep. NTIS, PC A02/MF A01
6869	2:57197	Dep. NTIS, PC A02/MF A01
6869-MS	2:57198	Dep. NTIS, PC A02/MF A01
6873-MS	2:57345	Dep. NTIS, PC A02/MF A01
6883-MS	2:57194	Dep. NTIS, PC A02/MF A01
LA-NUREG-		
6623	2:56785	Dep. NTIS, PC A07/MF A01
LA-tr-		
77-26	2:57166	Dep. NTIS, PC A03/MF A01
LA-UR-		
77-365	2:57416	Dep. NTIS, PC A02/MF A01
77-894	2:57811	Dep. NTIS, PC A02/MF A01
77-992	2:57417	Dep. NTIS, PC A02/MF A01
77-1033	2:57788	Dep. NTIS, PC A02/MF A01
77-1098	2:57181	NTIS, MF A01
77-1142	2:57661	Dep. NTIS, PC A02/MF A01
77-1261	2:57164	Dep. NTIS, PC A02/MF A01
77-1292	2:57113	Dep. NTIS, PC A02/MF A01
77-1345	2:57812	Dep. NTIS, PC A02/MF A01
77-1378	2:57346	Dep. NTIS, PC A02/MF A01
LBL-		
5214	2:57355	Dep. NTIS, PC A04/MF A01
5772	2:57091	Dep. NTIS, PC A04/MF A01
6012	2:57114	Dep. NTIS, PC A04/MF A01
6221	2:57211	Dep. NTIS, PC A11/MF A01
6266	2:57105	Dep. NTIS, PC A03/MF A01
6305	2:56169	Dep. NTIS, PC A02/MF A01
6324	2:56201	Dep. NTIS, PC A02/MF A01
LMSC-		
D501012	2:57491	*See* N-77-16485
LSU-R-		
76-013	2:56958	*See* PB-265447
M-		
76-68	2:56923	*See* PB-265398
196	2:57093	*See* N-77-16082
MERC/RI-		
77/1	2:55779	Dep. NTIS, PC A06/MF A01
77/2	2:55713	Dep. NTIS, PC A03/MF A01
MF-		
86	2:57660	*See* COO-3077-137
MHSMP-		
77-20	2:57347	Dep. NTIS, PC A02/MF A01
MIT/EL-		
76/007WP	2:56971	*See* PB-265093
76/010WP	2:56917	*See* PB-265113
76-015WP	2:56970	*See* PB-265015
76/023WP	2:56952	*See* PB-265108
MLM-		
2391	2:55969	Dep. NTIS, PC A02/MF A01
2426(OP)	2:56652	Dep. NTIS, PC A02/MF A01
2428	2:57277	Dep. NTIS, PC A03/MF A01
2429	2:55955	Dep. NTIS, PC A02/MF A01
2436	2:55901	Dep. NTIS, PC A02/MF A01
2438(OP)	2:57273	Dep. NTIS, PC A03/MF A01
2441(TR)	2:57374	Dep. NTIS, PC A02/MF A01
N-		
76-31332	2:55548	Dep. NTIS, PC A03/MF A01
77-10661	2:56898	NTIS, PC A04/MF A01
77—16075	2:57092	NTIS PCA04/MF A01
77—16082	2:57093	NTIS PCA14/MF A01
77—16115	2:57163	NTIS PCA02/MF A01
77—16149	2:57115	NTIS PCA03/MF A01
77—16248	2:57493	NTIS PCA05/MF A01
77—16437	2:56888	NTIS PCA08
77—16442	2:56076	NTIS PCA07/MF A01
77—16443	2:56077	NTIS PCA99/MF A01
77—16444	2:56999	NTIS PCA04/MF A01
77—16445	2:56997	NTIS PCA02/MF A01
77—16446	2:56098	NTIS PCA03/MF A01
77—16447	2:56080	NTIS PCA14/MF A01
77—16485	2:57491	NTIS PCA05/MF A01
77-16683	2:57440	NTIS PCA02/MF A01
77-16976	2:57482	NTIS PCA02/MF A01
77—16977	2:57483	NTIS PCA03/MF A01
77-16979	2:57492	NTIS PCA07/MF A01
77-16980	2:57485	NTIS PCA02/MF A01
NASA-CR-		
135149	2:57493	*See* N-77-16248
149452	2:57482	*See* N-77-16976
149453	2:57483	*See* N-77-16977
149490	2:57491	*See* N-77-16485
150156	2:57092	*See* N-77-16075
150171	2:56080	*See* N-77-16447
NASA-SP-		
7044	2:56888	*See* N-77-16437
NASA-TM-X-		
73-166	2:55548	*See* N-76-31332
3458	2:57093	*See* N-77-16082
3466	2:57163	*See* N-77-16115
71262	2:57485	*See* N-77-16980
72753	2:56098	*See* N-77-16446
73358	2:57492	*See* N-77-16979
73359	2:57115	*See* N-77-16149
73655	2:56042	*See* ERDA/NASA/1022-77/10
73657	2:56043	*See* ERDA/NASA/1022-77/13
73669	2:57000	*See* ERDA/NASA/1002-77/10
74309	2:56076	*See* N-77-16442
74310	2:56077	*See* N-77-16443
NASA-TN-D-		
8396	2:56997	*See* N-77-16445
NASA-TT-F-		
17367	2:56999	*See* N-77-16444
NBS-HB-		
121	2:57043	*See* PB-264959
NIRS-M-		
10	2:57400	Dep. NTIS (US Sales Only), PC A03/MF A01
NP-		
21685	2:57350	Dep. NTIS (US Sales Only), $5.50
21722	2:56195	Parametrix, Inc., Seattle, WA
21852	2:57001	Florida State Energy Office, Tallahassee, FL, $4.50
21880	2:56949	Virginia Energy Resource Advisory Commission, Richmond, VA
22076	2:55655	Montana Energy Advisory Council, Helena, MT
22092	2:55614	Montana Energy Advisory Council, Helena, MT
22108	2:57182	International Business Machines Corporation, Hopewell Junction, NY
22113	2:56721	Combustion Engineering, Inc., Windsor, CT
22116	2:55658	Ford, Bacon and Davis, Inc., New York, NY
22126	2:55644	Dep. NTIS (US Sales Only), PC A08/MF A01
22192	2:56430	Institute of Gas Technology, Chicago, IL
22197	2:55756	Electrofrac Corp., Kansas City, MO
22244(Vol.1)	2:56344	Stearns-Roger Inc., Denver, CO
22244(Vol.2)	2:56357	Stearns-Roger Inc., Denver, CO
22250	2:56955	Dep. NTIS, PC A07/MF A01
22267	2:57003	Cold Regions Research and Engineering Lab., Hanover, NH
22279	2:55659	New Mexico Bureau of Mines and Mineral Resources, Socorro,, $6.00
22280	2:56182	New Mexico Bureau of Mines and Mineral Resources, Socorro, NM
22295	2:56986	TIC
22364	2:55818	Institute of Gas Technology, Chicago, IL
NP-tr-		
1974	2:56749	Dep. NTIS (US Sales Only), PC A03/MF A01
1977	2:56877	Nuclear Regulatory Commission, Washington, DC
1979	2:56407	NTIS
1980	2:56580	Dep. NTIS (US Sales Only), PC A03/MF A01
NRL-MR-		
3525	2:57768	Dep. NTIS, PC A03/MF A01
NTISUB/B-		
125-76/011	2:55782	Paper copy also available on subscription, North American Continent price, $25.00/year; all others write for quote
NUREG-		
0090-5	2:56585	*See* PB-265676

Report No.	Abstract No.	Availability
0199	2:56582	NTIS, $7.75
0227	2:56586	*See* PB-265794
0279	2:55896	Dep. NTIS, PC A11/MF A01
0290(Vol.1)	2:55956	Dep. NTIS, PC A07/MF A01
0290(Vol.2)	2:55957	Dep. NTIS, PC A11/MF A01
0290(Vol.3)	2:55958	Dep. NTIS, PC A07/MF A01
0292	2:56583	Dep. NTIS, PC A06/MF A01
0301	2:57430	Dep. NTIS, PC A05/MF A01
0350(Vol.1)(No.1)	2:55959	NTIS, $4.50
766510	2:57278	*See* SAND-76-0427
NUREG/PRDI-		
77/4	2:56584	TIC, $3.70
NVO-		
1253-11	2:57383	Dep. NTIS, PC A02/MF A01
ORAU/IEA-		
76-4	2:56741	Dep. NTIS, PC A06/MF A01
ORAU/IEA(O)-		
77-15	2:55656	Dep. NTIS, PC A02/MF A01
ORC-		
76-32	2:55902	*See* UCRL-13733-1
ORNL-		
5151	2:57351	Dep. NTIS, PC A03/MF A01
5209(Vol.1)	2:55615	Dep. NTIS, PC A11/MF A01
5209(Vol.3)	2:55616	*See* ORNL-5211
5211	2:55616	Dep. NTIS, PC A03/MF A01
5212(Vol.2)	2:55558	*See* ORNL-5213
5213	2:55558	Dep. NTIS, PC A04/MF A01
5273	2:57116	AT
5312	2:55583	Dep. NTIS, PC A08/MF A01
ORNL/CON-		
10	2:57014	Dep. NTIS, PC A04/MF A01
ORNL/CSD/TM-		
27	2:57628	Dep. NTIS, PC A06/MF A01
30	2:57813	Dep. NTIS, PC A09/MF A01
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ORNL/NUREG/NSIC-		
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ORNL/NUREG/TM-		
112	2:56368	Dep. NTIS, PC A03/MF A01
ORNL/SUB-		
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ORNL/TIRC-		
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5034	2:55617	Dep. NTIS, PC A09/MF A01
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Report No.	Abstract No.	Availability
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4,028,068	2:55992	
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264151	2:56112	NTIS, PC A03/MF A01
264200	2:56909	NTIS PCE10/MF E10
264362	2:57356	NTIS PCA04/MF A01
264429	2:57281	NTIS PCA06/MF A01
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264439	2:55733	NTIS PCA08/MF A01
264440	2:55734	NTIS PCA06/MF A01
264457	2:56926	NTIS PCA06/MF A01
264460	2:55786	NTIS PCA02/MF A01
264467	2:56591	NTIS PCA08/MF A01
264468	2:56592	NTIS PCA05/MF A01
264471	2:57316	NTIS PCA04/MF A01
264494	2:56927	NTIS PCA05/MF A01
264516	2:57073	NTIS PCA04/MF A01
264529	2:56922	NTIS PCA09/MF A01
264543	2:57035	NTIS PCA06/MF A01
264561	2:56928	NTIS PCA12/MF A01
264564	2:56593	NTIS PCA10/MF A01
264565	2:56594	NTIS PCA04/MF A01
264575	2:56956	NTIS PCA04/MF A01
264611	2:56935	NTIS PCA06/MF A01
264635	2:56940	NTIS PCA03/MF A01
264649	2:56951	NTIS PCA02/MF A01
264702	2:57094	NTIS PCA13/MF A01
264750	2:56002	NTIS PCA05/MF A01
264753	2:56012	NTIS PCA13/MF A01
264759	2:57015	NTIS PCA03/MF A01
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264822	2:57357	NTIS PCA15/MF A01
264823	2:57358	NTIS PCA05/MF A01
264870	2:55792	NTIS PCA16/MF A01
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264886	2:56929	NTIS PCA16/MF A01
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264904	2:57004	NTIS PCA06/MF A01
264914	2:57441	NTIS PCA07/MF A01
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264959	2:57043	NTIS PCA09/MF A01
264997	2:55672	NTIS PCA04/MF A01
265015	2:56970	NTIS PCA02/MF A01
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265098	2:56790	NTIS PCA06/MF A01
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265101	2:57359	NTIS PCA03/MF A01
265105	2:56092	NTIS PCA06/MF A01
265108	2:56952	NTIS PCA05/MF A01
265113	2:56917	NTIS PCA03/MF A01
265115	2:57458	NTIS PCA08/MF A01
265116	2:56204	NTIS PCA09/MF A01
265131	2:56941	NTIS PCA08/MF A01
265143	2:56972	NTIS PCA06/MF A01
265182	2:55660	NTIS PCA05/MF A01
265229	2:55648	NTIS PCA06/MF A01
265282	2:56022	NTIS PCA04/MF A01
265295	2:56918	NTIS PCA06/MF A01
265346	2:57402	NTIS PCA04/MF A01
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265369	2:57030	NTIS PCA11/MF A01
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265381	2:57360	NTIS PCA17/MF A01
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265387	2:57024	NTIS PCA07/MF A01
265390	2:57394	NTIS PCA18/MF A01
265392	2:56000	NTIS PCA04/MF A01
265398	2:56923	NTIS PCA13/MF A01
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265676	2:56585	NTIS PCA02/MF A01
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PGE-		
8003(Rev.1)(Att.2)	2:56587	Portland General Electric Co., Portland, OR
PNC-J-		
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PNCT-		
841-75-37	2:55868	Dep. NTIS (US Sales Only), PC A04/MF A01
POLY-EE/EP-		
76-011	2:57674	*See* AD-A-037663
PPPL-		
1349	2:57663	Dep. NTIS, PC A02/MF A01
1354	2:57664	Dep. NTIS, PC A08/MF A01
PPSP-CPCTP-		
12(Vol.1)	2:57362	Dep. NTIS, PC A13/MF A01
12(Vol.2)	2:57363	Dep. NTIS, PC A13/MF A01
PRRL-		
77-CR-4	2:56037	*See* ERDA/JPL/954352-77/1
PRS-		
18	2:55649	*See* PB-265374
R-		
1979-AF	2:57167	RAND, Santa Monica, CA
RDT-C-		
8-8T(7-77)	2:57195	RSO
RFP-Trans-		
225	2:57204	Dep. NTIS, PC A02/MF A01
RLO-		
2231-T1-9	2:57399	Dep. NTIS, PC A02/MF A01
SAN-		
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SAN/1011-		
103	2:56792	AT
106	2:56793	AT
SAN/1132-		
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SAND-		
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77-0366C	2:57189	Dep. NTIS, PC A02/MF A01
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77-0999	2:55963	Dep. NTIS, PC A03/MF A01
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77-1056C	2:57156	Dep. NTIS, PC A03/MF A01

Report No.	Abstract No.	Availability
77-6009	2:56902	Dep. NTIS, PC A02/MF A01
77-6013	2:55970	
77-8243	2:56086	Dep. NTIS, PC A03/MF A01
77-8249	2:55964	Dep. NTIS, PC A03/MF A01
SB-		
11	2:57024	*See* PB-265387
SRO-TWM-		
77-1	2:55916	Dep. NTIS, PC A14/MF A01
STH-		
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STI/PUB-		
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450	2:55855	IAEA, $21.00
SU-		
326-P.39-19	2:57815	Dep. NTIS, PC A02/MF A01
SU-IPR-		
668	2:57482	*See* N-77-16976
669	2:57483	*See* N-77-16977
TID-		
8200-R36	2:56362	Dep. NTIS, PC A02/MF A01
27147	2:56988	Dep. NTIS, PC A08/MF A01
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27639	2:56794	Dep. NTIS, PC A05/MF A01
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27672	2:57075	Dep. NTIS, PC A02/MF A01
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27697	2:56044	Dep. NTIS, PC A02/MF A01
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TOP-		
2-2-506	2:57072	*See* AD-A-037827
TR-EE/EL-		
8	2:57315	*See* ORNL/Sub-3961/2
TREE-		
1135	2:57036	Dep. NTIS, PC A03/MF A01
1145	2:55965	Dep. NTIS, PC A05/MF A01
TREE-NUREG-		
1058	2:56408	Dep. NTIS, PC A05/MF A01
1107	2:56369	Dep. NTIS, PC A13/MF A01
TRG-Report-		
2819(D)	2:56541	Dep. NTIS (US Sales Only), PC A02/MF A01
TT-		
72-52017/09	2:57089	*See* AEC-tr-7297/9
UCID-		
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17090(Rev.1)	2:57816	Dep. NTIS, PC A02/MF A01
17456	2:57313	Dep. NTIS, PC A05/MF A01
17490	2:57368	Dep. NTIS, PC A02/MF A01
17492	2:55834	Dep. NTIS, PC A02/MF A01
17507	2:57212	Dep. NTIS, PC A02/MF A01
17540	2:57348	Dep. NTIS, PC A02/MF A01
30151	2:57817	Dep. NTIS, PC A02/MF A01
30152	2:57818	Dep. NTIS, PC A03/MF A01
UCLA-		
34P214-37	2:57819	IEEE Computer Society, Long Beach, CA
34P214-40	2:57820	IEEE Computer Society, Long Beach, CA
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UCLA-ENG-		
7711	2:56790	*See* PB-265098
76112	2:56791	*See* PB-265099
76113	2:56789	*See* PB-265020
76125	2:57458	*See* PB-265115
UCRL-		
5225	2:55584	Dep. NTIS, PC A03/MF A01
13720	2:57769	Dep. NTIS, PC A06/MF A01
13726	2:57154	Dep. NTIS, PC A04/MF A01
13727	2:57675	Dep. NTIS, PC A02/MF A01
13733-1	2:55902	Dep. NTIS, PC A03/MF A01
13735-2	2:57770	Dep. NTIS, PC A03/MF A01
50033-77-1	2:56886	Dep. NTIS, PC A02/MF A01
50045-77-1	2:56795	Dep. NTIS, PC A05/MF A01
51879(Pt.5)	2:57437	Dep. NTIS, PC A04/MF A01
52256(Pt.1)	2:55835	Dep. NTIS, PC A03/MF A01
52258	2:57461	Dep. NTIS, PC A03/MF A01
52262	2:55968	Dep. NTIS, PC A02/MF A01
52277	2:57822	Dep. NTIS, PC A02/MF 01
76834	2:57286	Dep. NTIS, PC A03/MF A01
78367	2:57252	Dep. NTIS, PC A02/MF A01
78886	2:57253	Dep. NTIS, PC A02/MF A01
79011	2:57474	Dep. NTIS, PC A03/MF A01
79032	2:57106	Dep. NTIS, PC A02/MF A01
79034	2:55836	Dep. NTIS, PC A04/MF A01
79146	2:55650	Dep. NTIS, PC A02/MF A01
79149	2:55837	Dep. NTIS, PC A02/MF A01
79214	2:55966	Dep. NTIS, PC A02/MF A01
79214(Rev.1)	2:57384	Dep. NTIS, PC A02/MF A01
79259	2:57623	Dep. NTIS, PC A02/MF A01
79277	2:56796	Dep. NTIS, PC A02/MF A01
79286	2:57832	Dep. NTIS, PC A03/MF A01
79287	2:57823	Dep. NTIS, PC A02/MF A01
79308	2:57824	Dep. NTIS, PC A02/MF A01
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79328(Pt.1)	2:57826	Dep. NTIS, PC A03/MF A01
79357	2:57833	Dep. NTIS, PC A02/MF A01
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79391	2:57349	Dep. NTIS, PC A02/MF A01
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79604	2:57676	Dep. NTIS, PC A02/MF A01
79628	2:57772	Dep. NTIS, PC A02/MF A01
79712	2:57118	Dep. NTIS, PC A03/MF A01
UCRL-Trans-		
11236	2:57620	Dep. NTIS, PC A03/MF A01
UMD-		
4908-8	2:56100	Dep. NTIS, PC A02/MF A01
USGS-BULL-		
1421-C	2:56208	GPO, $0.70
USGS-CIRC-		
757	2:55547	Geological Survey, Arlington, VA
USGS-OFR-		
76-869	2:55661	TIC
77-130	2:55757	TIC
USGS/WRD/WRI-		
77/020	2:57402	*See* PB-265346
USGS/WRI-		
77-6	2:57402	*See* PB-265346
UWFDM-		
184	2:57143	Dep. NTIS, PC A03/MF A01
VHTRC-		
77-R15	2:56940	*See* PB-264635
WARD-AD-		
3045-5	2:57119	AT
WCAP-		
8183(Rev.6)	2:56409	Westinghouse Electric Corp., Pittsburgh, PA
X-		
660-76-284	2:57485	*See* N-77-16980
X-OE-		
17	2:55920	*See* Y/OWI/TM-9
XN-		
76-47(NP)	2:56797	Exxon Nuclear Co., Inc., Richland, WA
Y-		
2078	2:57242	Dep. NTIS, PC A02/MF A01
Y/DA-		
7177	2:57254	Dep. NTIS, PC A02/MF A01
Y/OWI/SUB-		
76/7253/1	2:55917	Dep. NTIS, PC A06/MF A01
77/22303/1	2:57475	Dep. NTIS, PC A04/MF A01
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4496/2	2:55918	Dep. NTIS, PC A03/MF A01
Y/OWI/TM-		
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Abbreviations Used in Availability Column

AT Liquid Metal Fast Breeder Reactor applied technology is available to domestic requesters within the United States from the Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.
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Issue #2

January 1977

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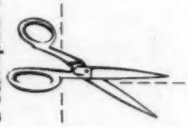

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